Contents

Specification of products are subject to change without notification

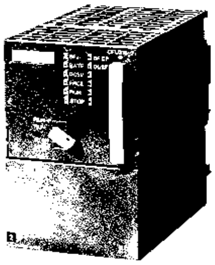
1. PLC/PC with analog interface
Move to freely adjustable positions

Task description

An adjustable linear movement is needed for laboratory equipment. The movement is calculated on-line by a PC or by a PLC and takes place within the range 20 mm to 70 mm. It should be possible to move to every position within this range.
For safety reasons acceleration should never be greater than 75 m/s2 and the velocity should never exceed 1,6 m/s

Additional task

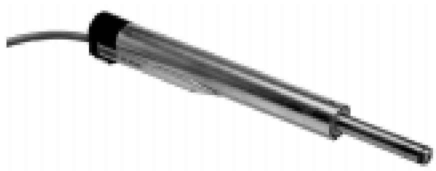
Reduce the max velocity to 0,2 m/s.



Position 1: 22 mm
Position 2: 55 mm
Position 3: 27 mm
Position 4: 55 mm
…
Position xx: 48 mm

Digital Outputs
Analog Outputs

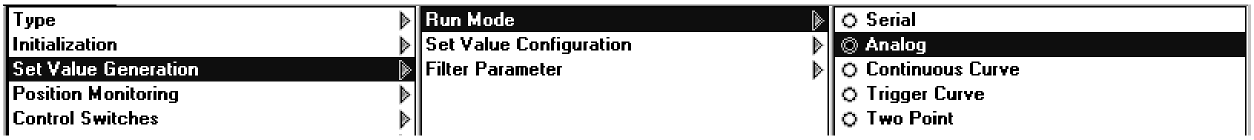
E400-AT



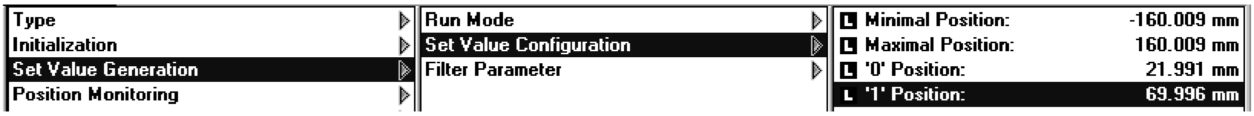
Solution

Position specification over 0 -10 V interface with limitation of acceleration and velocity.

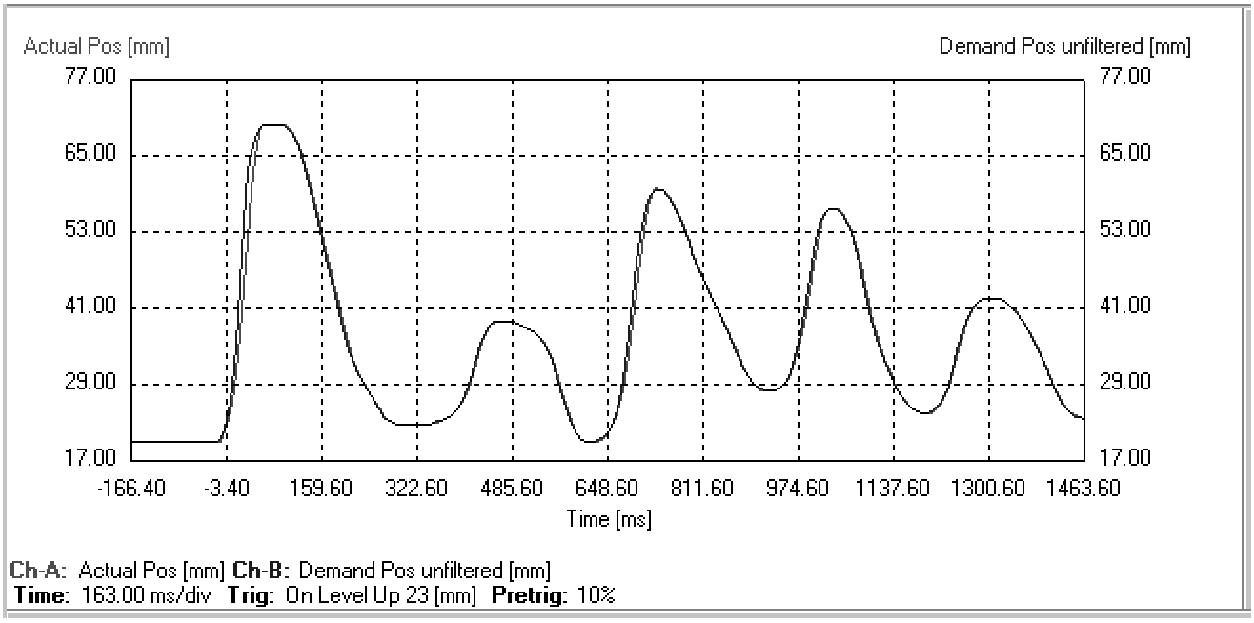
1. Selection of ‘Run’ mode



2. Specification of the scaling range 0 -10V → 0 -70 mm



3. Limitation of velocity and acceleration



Other solution:

Use RS-232/485 or Profibus

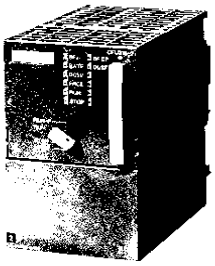
2. PLC/PC with digital output
Replacement of pneumatic cylinder

Task description

In an automation mechanism, a point to point movement from 22 mm to 68mm is needed. Acceleration may never become larger than 20 m/s2 and the velocity should be limited to 0,5 m/s. The superordinate control consists of a small PLC, which has four free digital outputs.

Additional task

Now make the same PLC control up to 10 different positions. Every position should have a dedicated acceleration and velocity limitation.



Position 1: 22 mm
Position 2: 68 mm

Digital Outputs

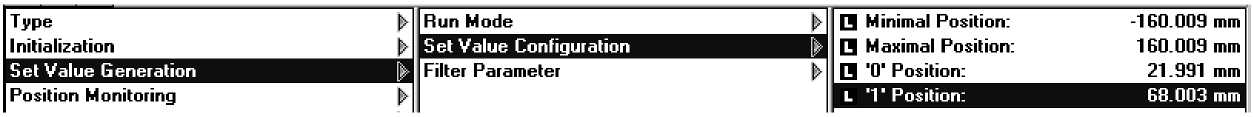
E400-AT

Solution

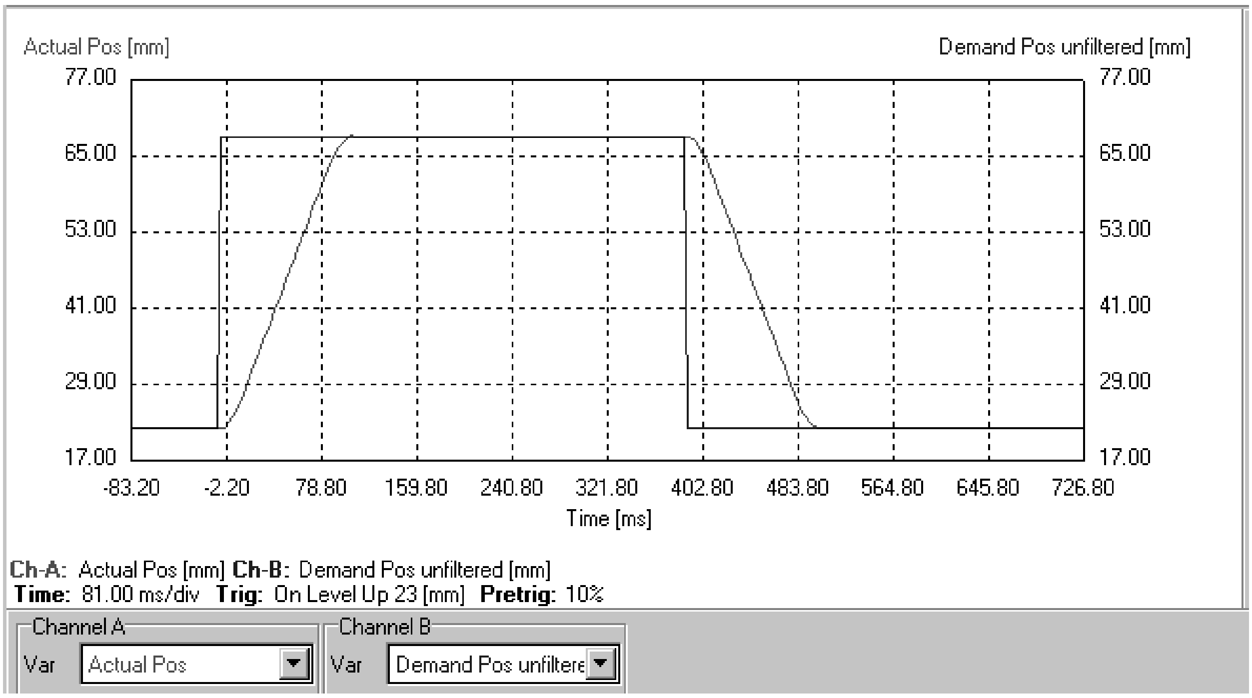
Use ‘Two point’ digital mode and limit acceleration and velocity.

1. Mode ‘Two Point’

2. Define the positions



3. Define acceleration and velocity limitations



Additional task :

Use Multitrigger Electronics and all four digital outputs of the PLC

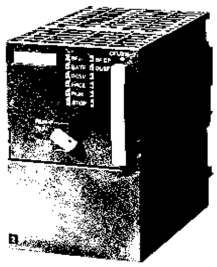
3. PLC/PC run profile movement
Pick and Place application

Task description

In an automated mechanism a ‘pick and place' movement is needed. The first movement goes from 30 mm to 70 mm, whereby the moving time may amount to 50ms. In order to avoid damage, the return motion must occur relatively slowly. Therefore a max. acceleration of 20 m/s2 and a deceleration of 10 m/s2 are specified. The velocity should never exceed 1,5 m/s.
The superordinate control consists of a small SPS, which has four free digital outputs.

Additional Task

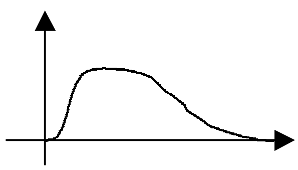
How could the same PLC drive up to 9 different pick and place movements ?

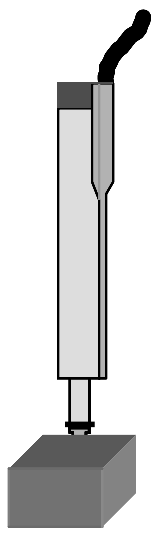


Move: 30 → 70 mm / 50 ms

Move : 70 → 30 mm / 20 m/s^2 and 10 m/s^2
v_{max}: 1.5m/s

4 digital Outputs





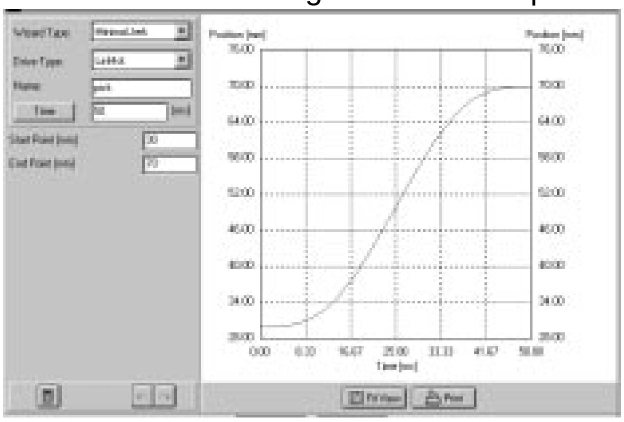
Solution

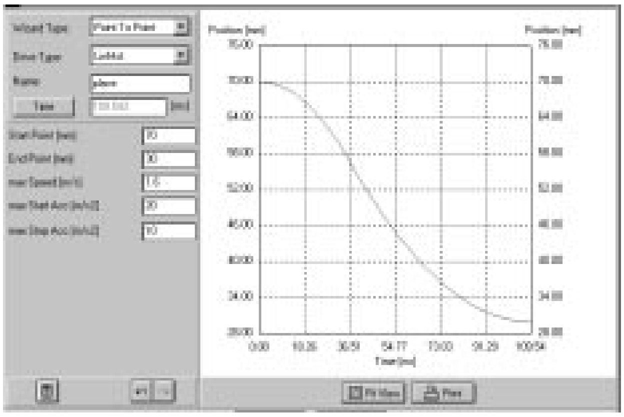
Position specification over trigger mode. The pick profile is produced with 'minimum jerk '. For the place movement, the 'Point to point' function in the Curve Inspector is used.

1. Select : Trigger Curve

2. Rising edge enables curve 1, falling edge is going to start curve 2

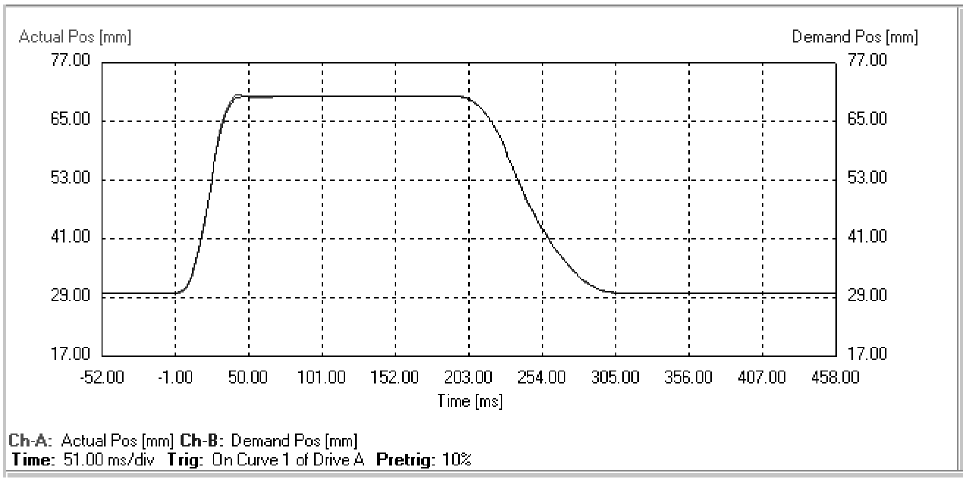
3. Create curves using the ‘Curve Inspector’





Pick movement: Minimal Jerk

Place movement: Point to Point



Additional task:

Use Multitrigger electronic unit and all four digital outputs of the PLC

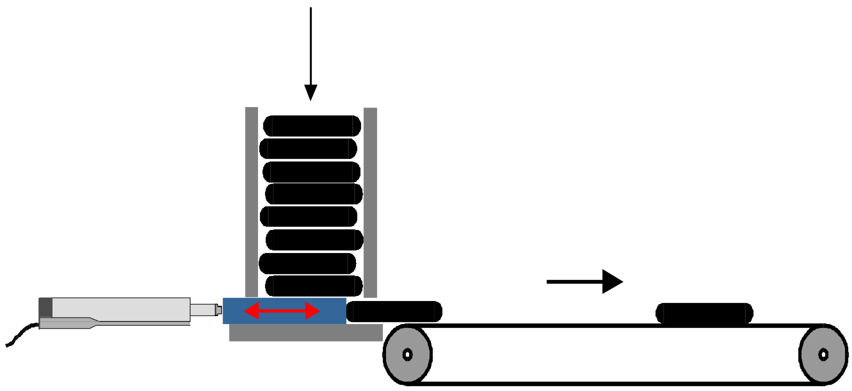
4. Velocity control by PLC/PC
Synchronization to conveyer velocity

Task description

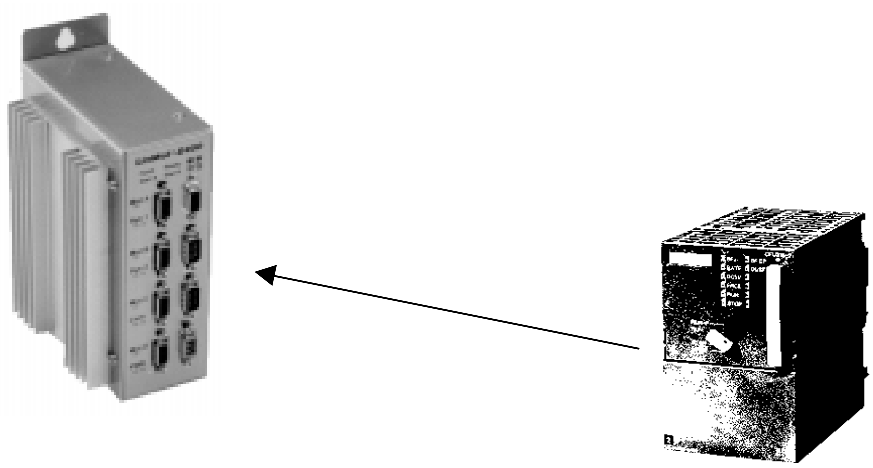
In an automated mechanism a candy is to be shifted onto a conveyor belt moving at a velocity of 0,8 m/s. In order to avoid damages or in order an exact adjustment of the candies, the shifting movement should be done at almost the same velocity of the conveyor. The superordinate control unit consists of a small PLC, which has only digital outputs.

Additional task

How could the production speed be improved?



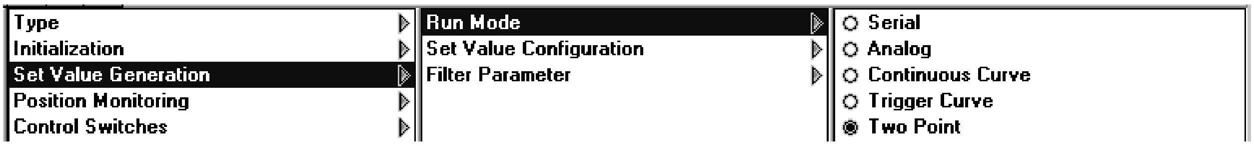
Length of the candy ca. 50 mm
Velocity of the conveyer: V:= 0.8 m/s



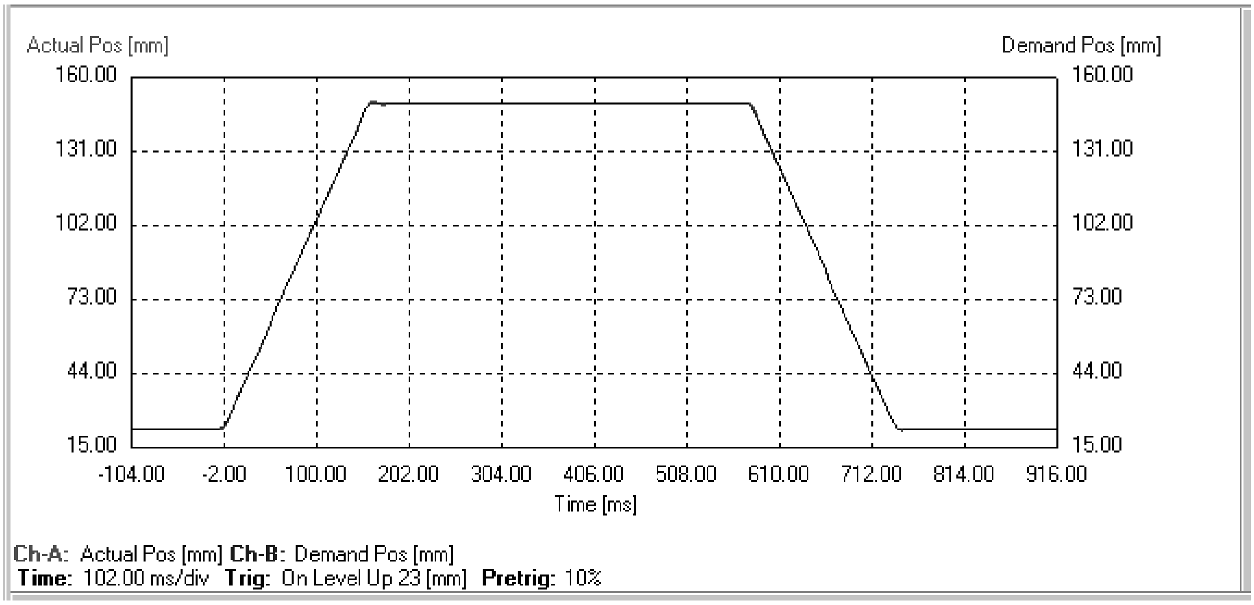
Solution

Use ‘two point’ mode and limit the velocity to 0.8 m/s.

1. Mode: Two Point



2. Limitof the velocity to 0.8 m/s



Additional task

By using a profile (curve mode) instead of a simple two point movement the speed of the returnmovement could be increased

5. Supervision of trailing errors (following error)
Detection of blocked packets

Task description

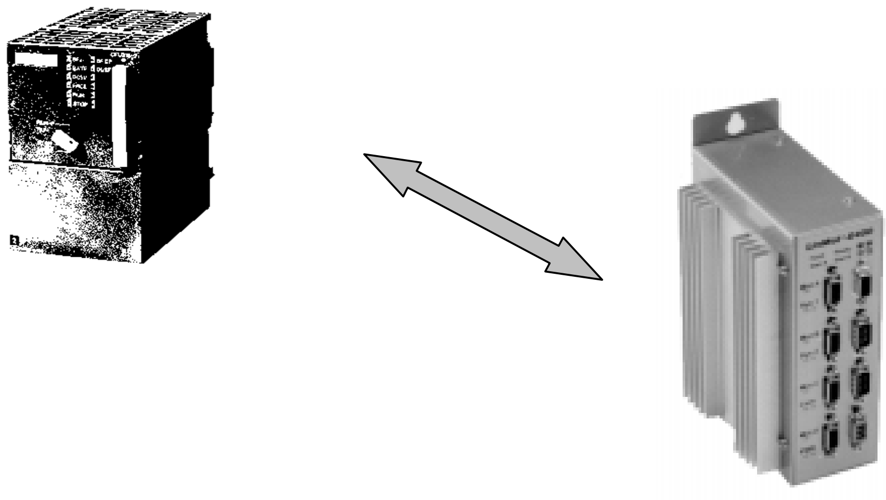
Packages are placed in a handling machine. Some of the packages are badly assembled, so there is a risk that some of them block the mechanism. When this happens, the handling machine must be stopped immediately.

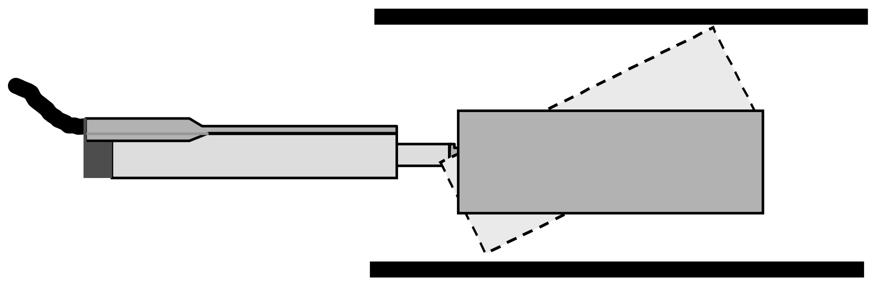
Stroke: 120 mm
Velocity: 1.1 m/s
Acceleration: 30 m/s^2

There is only an E400-AT electronic unit available to do the task.

Additional task

How can you ensure that the blocked packages are not destroyed as they pass through the motors?





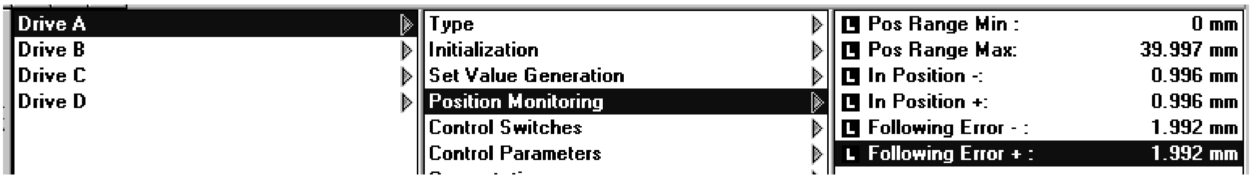
Solution

Use two point mode. Adjust the max. velocity to 1.1 m/s. Set max. acceleration to 30 m/s2. Monitor the error limit. As soon as the trailing error is larger than 2 mm, a warning will be sent. The superordinate control unit can stop the machine.

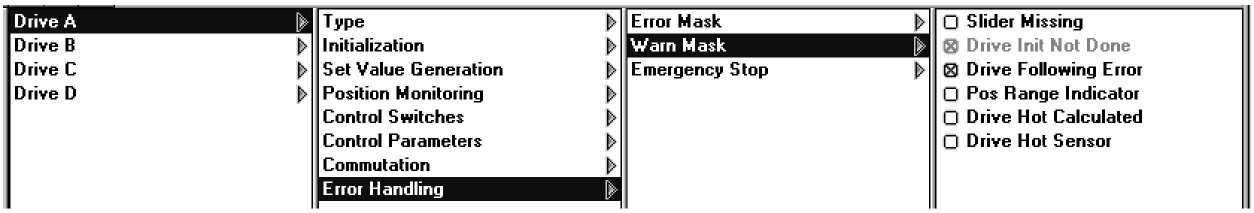
1. Select mode: Two Point and specify the stroke

2. Limit velocity and acceleration

3. Define trailing error band (called following error)



4. Enable ‚Warn Mask‘ on drive level



5. Disable additional possibilities of the ‚Warn Mask‘ on system level

Additional task

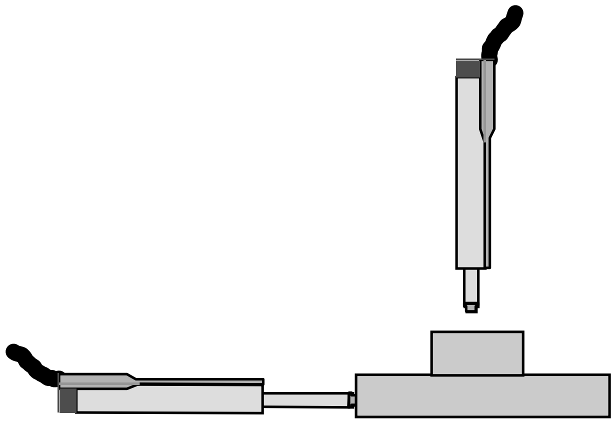
Activate force limiter (max. current)

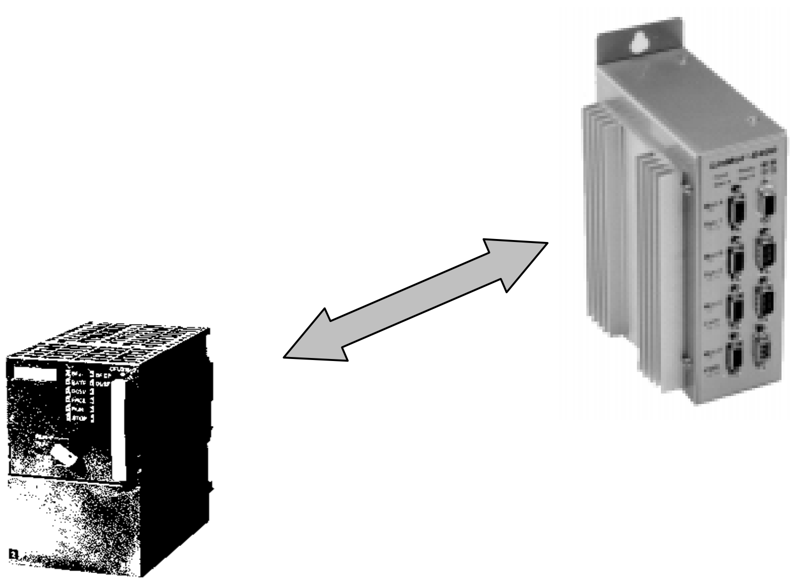
6. Position-Feedback to PLC/PC
Collision safety

Task description

two movements interlink in a handling machine. In order to be certain of avoiding a collisionthe linear motor will generate a signal, if the two movements pass within a distance of between 50 to 75 mm. The stroke range of the linear motor is from 20 to 90 mm, whereby the velocity must be limited to 0,5 m/s.

the only control unit available is the E400-AT .





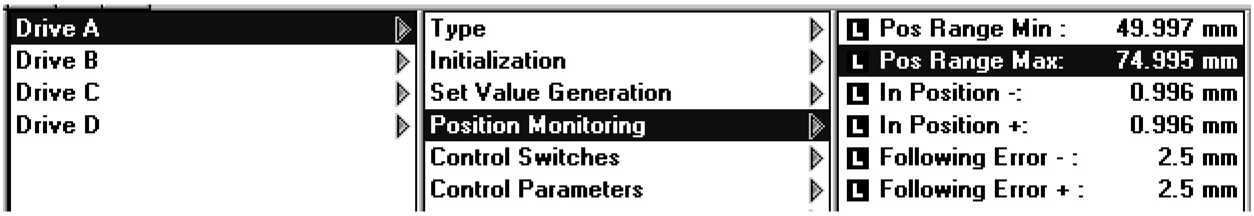
Solution

Use two point mode. Limit velocity and acceleration (0.5 m/s, e.g. to 30 m/s2). Set 'Pos Range ' to 50 to 75 mm. As soon as the slider is in the area between 50 to 75 mm, a 'pos error ' signal is activated.

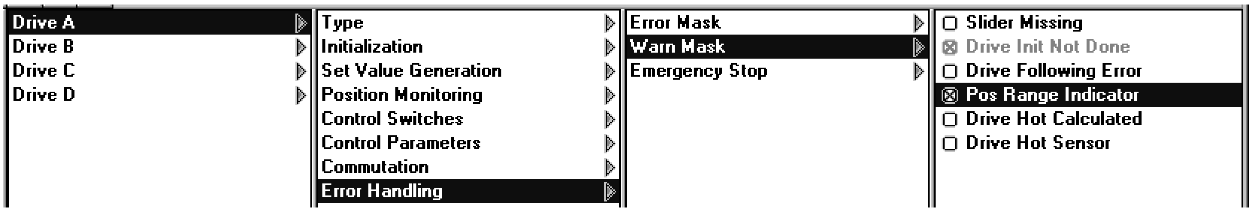
1. Select the stroke using Two Point mode

3. Limit velocity and acceleration

4. Adjust the position band

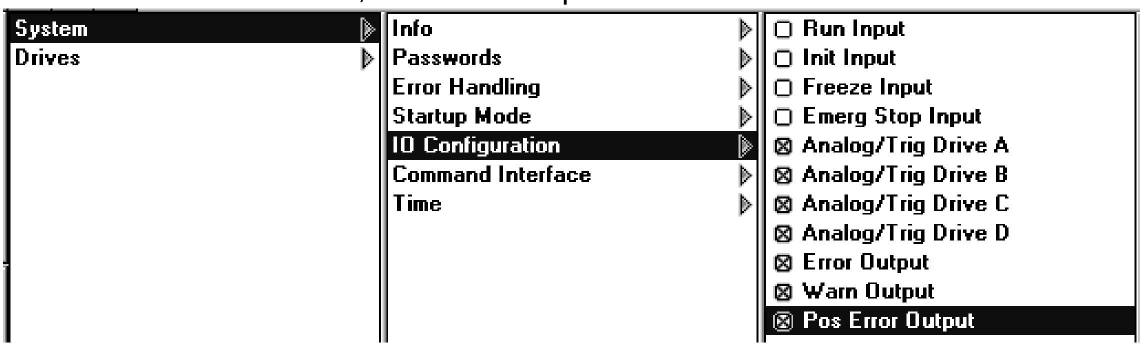


5. Enable Pos Range Indicator inside the ‚Warn Mask‘ on drive level



Remark: The position range signal is linked to the output ‘Pos Error Output‘ and not to the ‚Warn Output‘! But it must be enabled inside of the ‚Warn Mask‘.

6. Enable the hardware of the ‚Pos Error Output‘

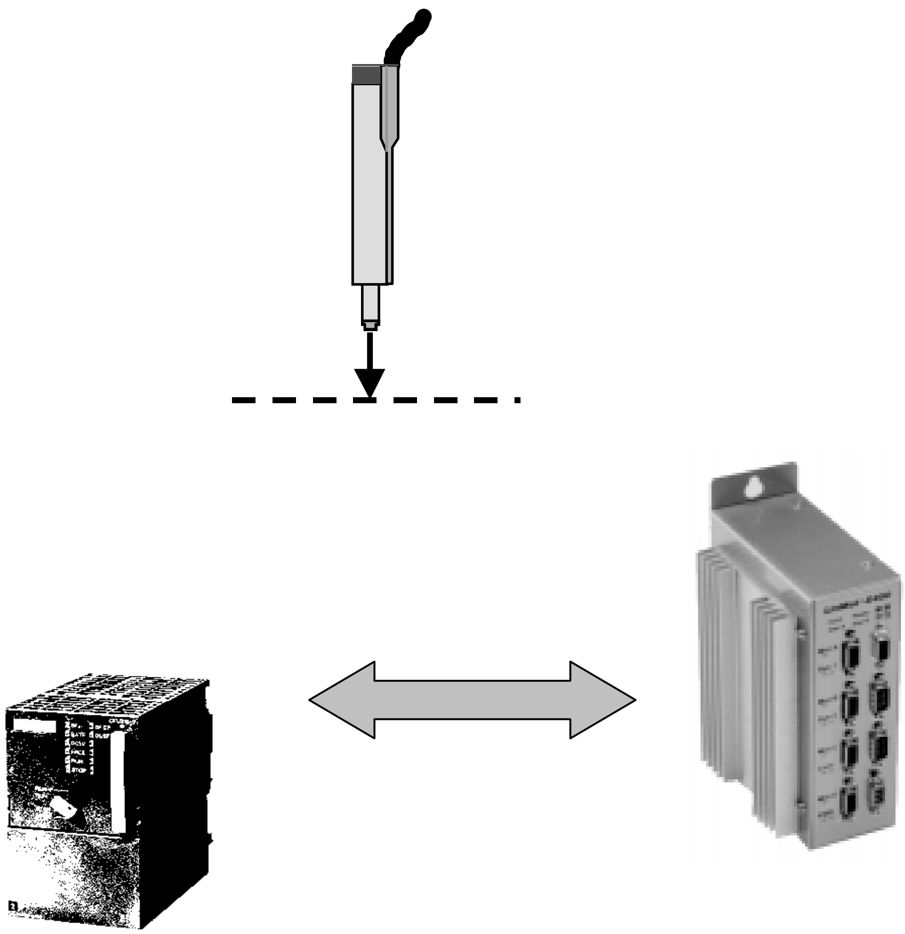


7. End position feedback (AT-electronic unit)
Monitoring of the end position

<u>Task description</u>

The superordinate control is to receive a signal, at exactly the moment the linear motor exactly achieves its final position (range 0,5 mm). The movement goes from 20 mm to 77 mm with a velocity of 0,3 m/s and acceleration of 20 m/s2.

Use an AT-electronic unit.



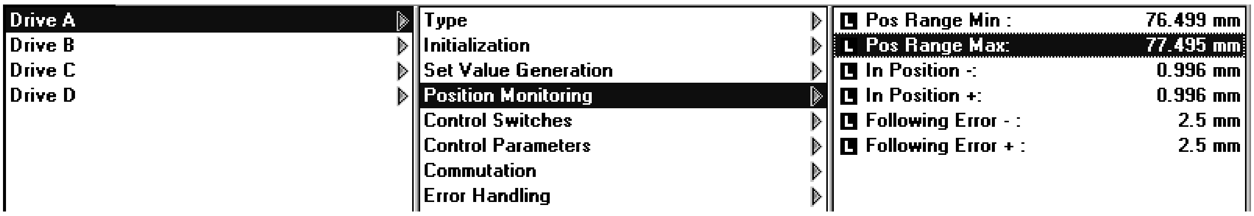
Solution

Use Two point mode. Limit velocity and acceleration. Set , Pos Range‘ to 76.5 and 77.5 mm. As soon as the slider will be in the range between 76.5 and 77.5 mm a ‚Pos Error‘ signal will be canceled.

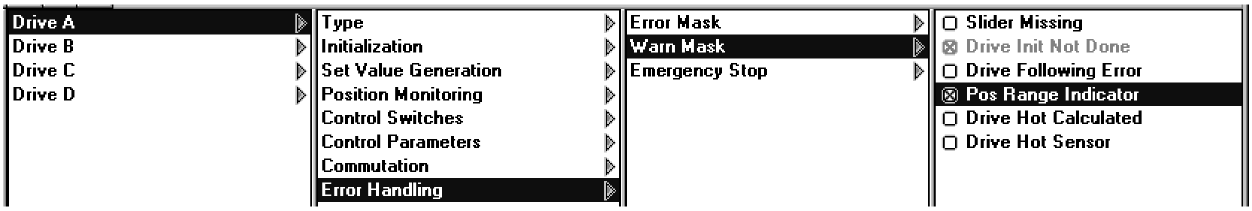
1. Use Two Point mode and adjust the stroke

3. Limit velocity and acceleration

4. Set the position band

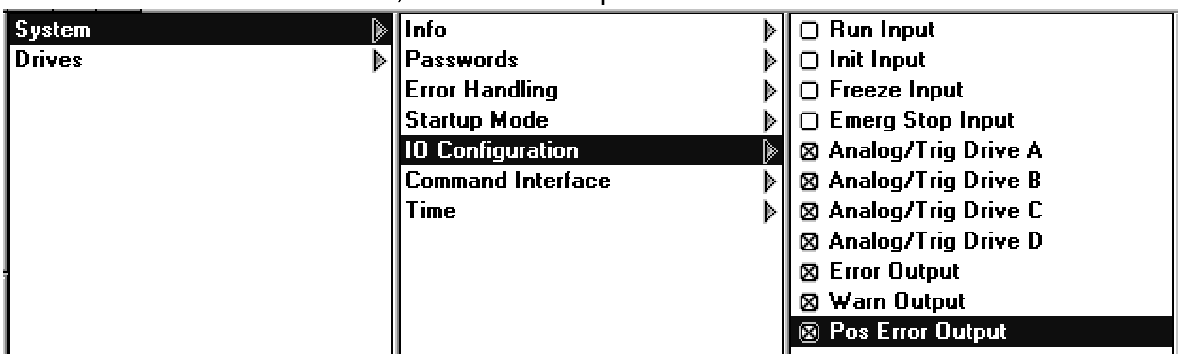


5. Enable Pos Range Indicator inside of the ‚Warn Mask‘ on drive level



Remark: The position range signal is linked to the output ‘Pos Error Output‘ and not to the ‚Warn Output‘! But it must be enabled inside the ‚Warn Mask‘.

6. Enable the hardware of the ‚Pos Error Output‘



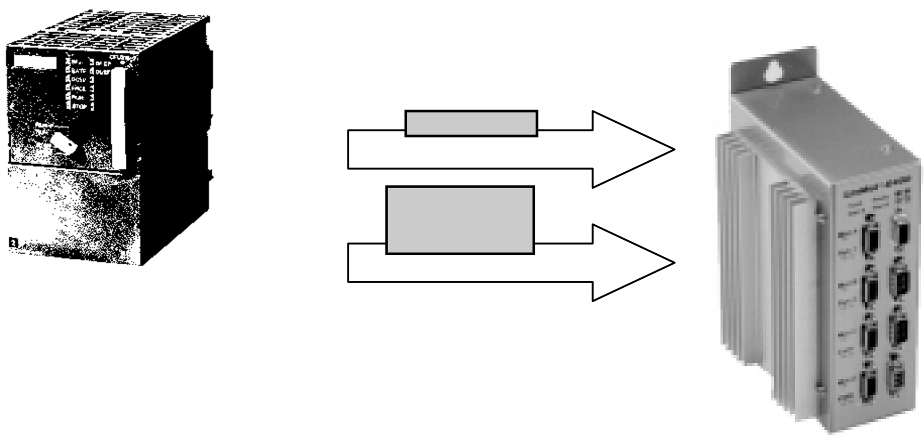
8. PLC/PC controls multiple positions/profiles
Change between different tasks

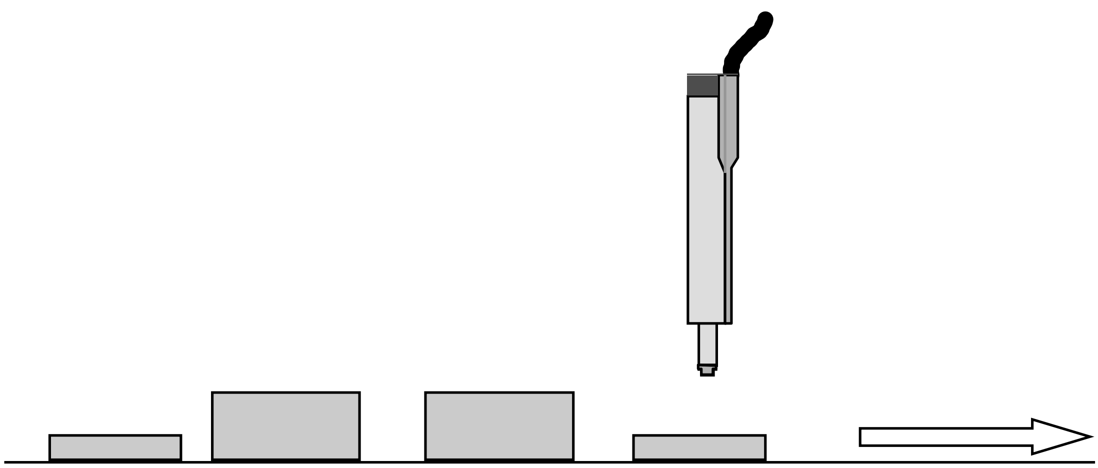
Task description

A handling machine assembles different parts during the day. Because of this, the stroke of the motor must be switched as well as all the velocity and acceleration values.

Small parts:	20 mm to 80 mm	v_{max}= 1.5 m/s	a_{max}:= 50 m/s^2
Big parts:	35 mm to 65 mm	v_{max}= 1.0 m/s	a_{max}:= 20 m/s^2

For this application, the PLC possesses only digital outputs with no serial or analog interface.



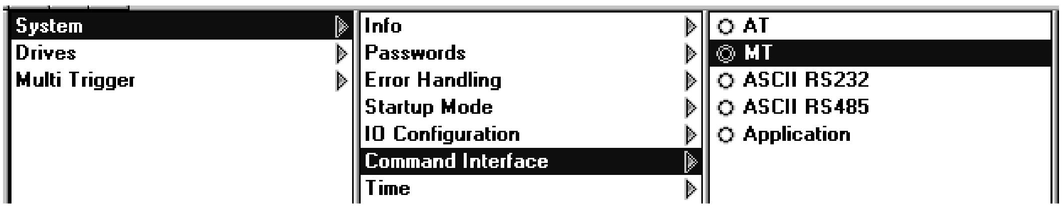


Solution

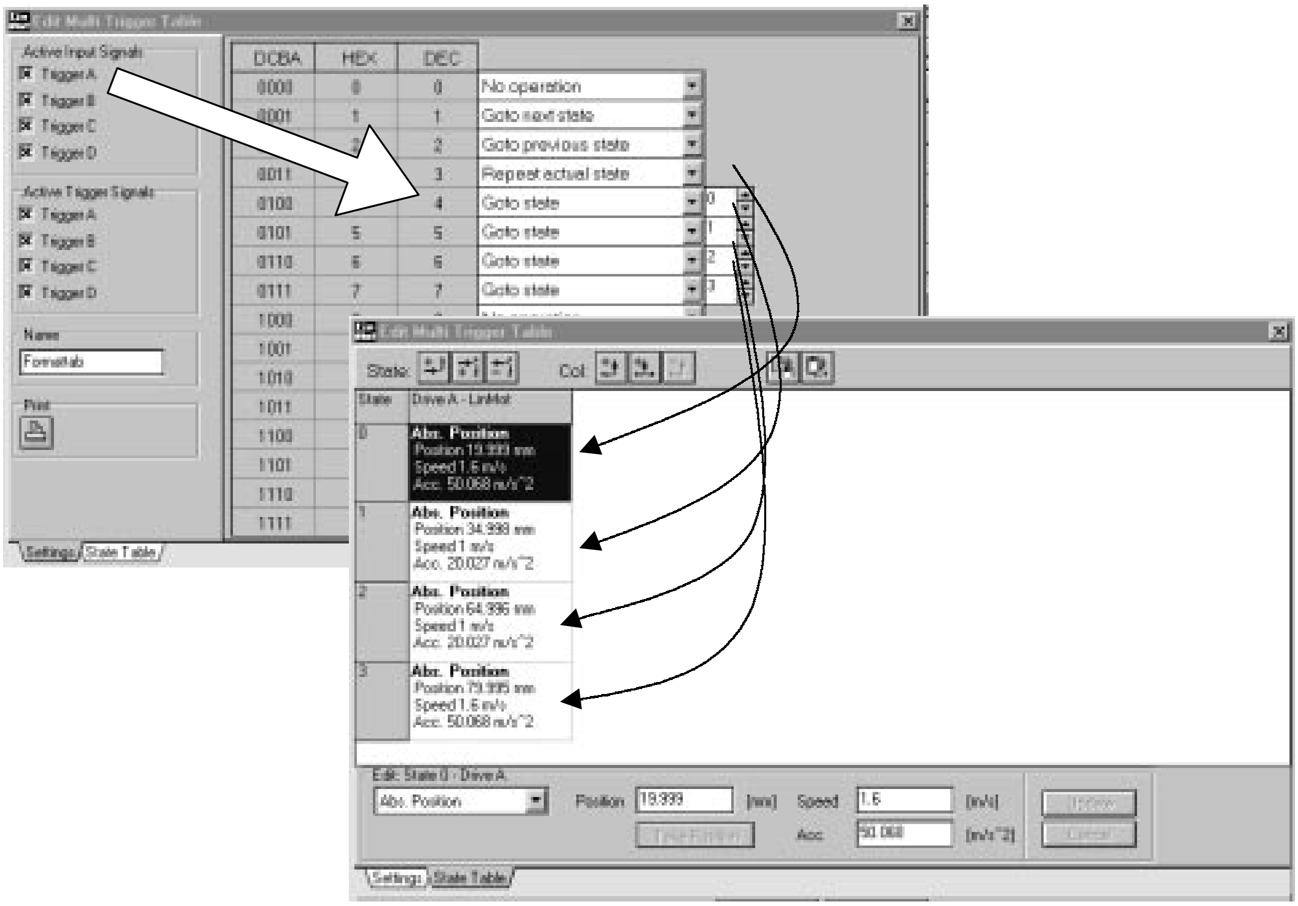
Use the multitrigger functionality. Create a multitrigger table with the following inputs:

Position 0 (State 0):	20mm	v_{max}= 1.5 m/s	a_{max}:= 50 m/s^2
Position 1 (State 2):	35mm	v_{max}= 1.0 m/s	a_{max}:= 20 m/s^2
Position 3 (State 3):	65mm	v_{max}= 1.0 m/s	a_{max}:= 20 m/s^2
Position 4 (State 4):	80mm	v_{max}= 1.5 m/s	a_{max}:= 50 m/s^2

1. Switch electronic unit to ‘Multitrigger’



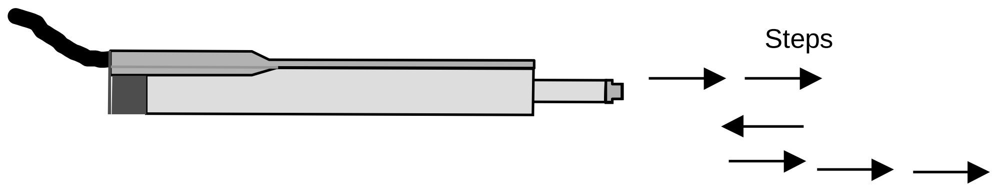
2. Create Multitrigger Table (use the built in ‘curve inspector’)

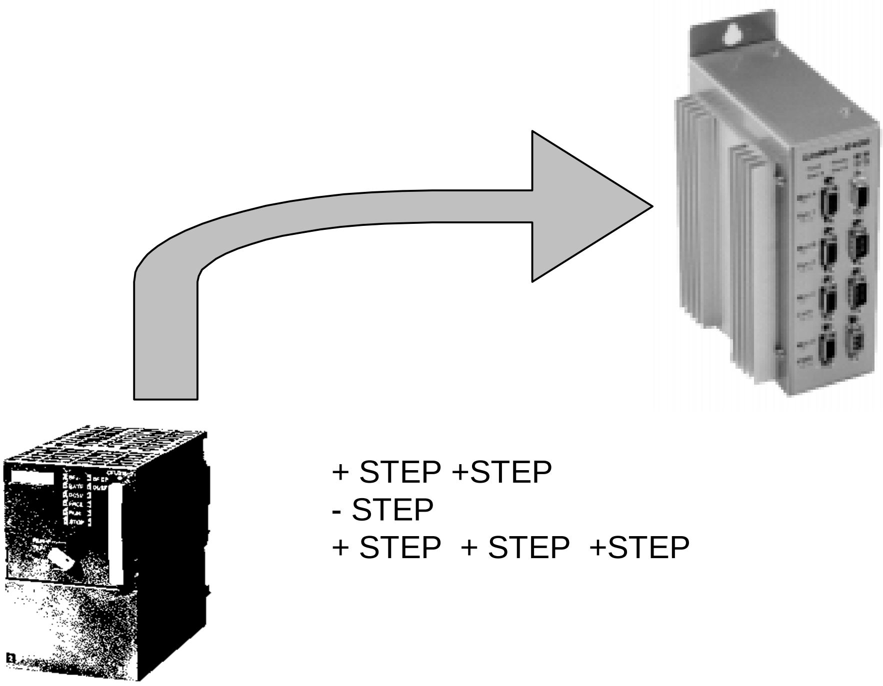


9. PLC/PC starts incremental movement
Linear motor plays stepper motor

Task description

A linear motor is integrated into an existing application; the control is made by digital signal lines of a PLC. The idea is that the PLC should operate the linear motor like a stepper motor. On a pulse signal generated by the PLC, the linear motor moves 1 mm forwards or backwards (relative motion).
Since the signals coming from the PLC possess a jitter, the jitter filter is set on 100 ms.

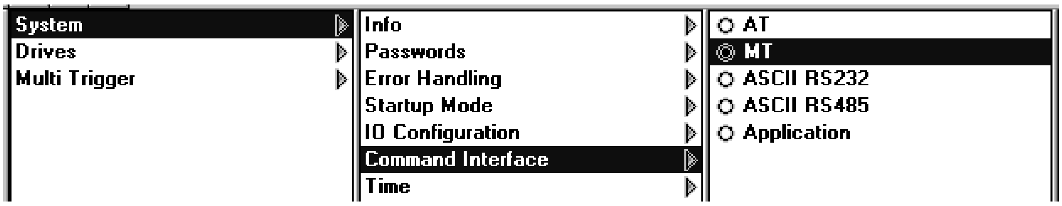




Solution

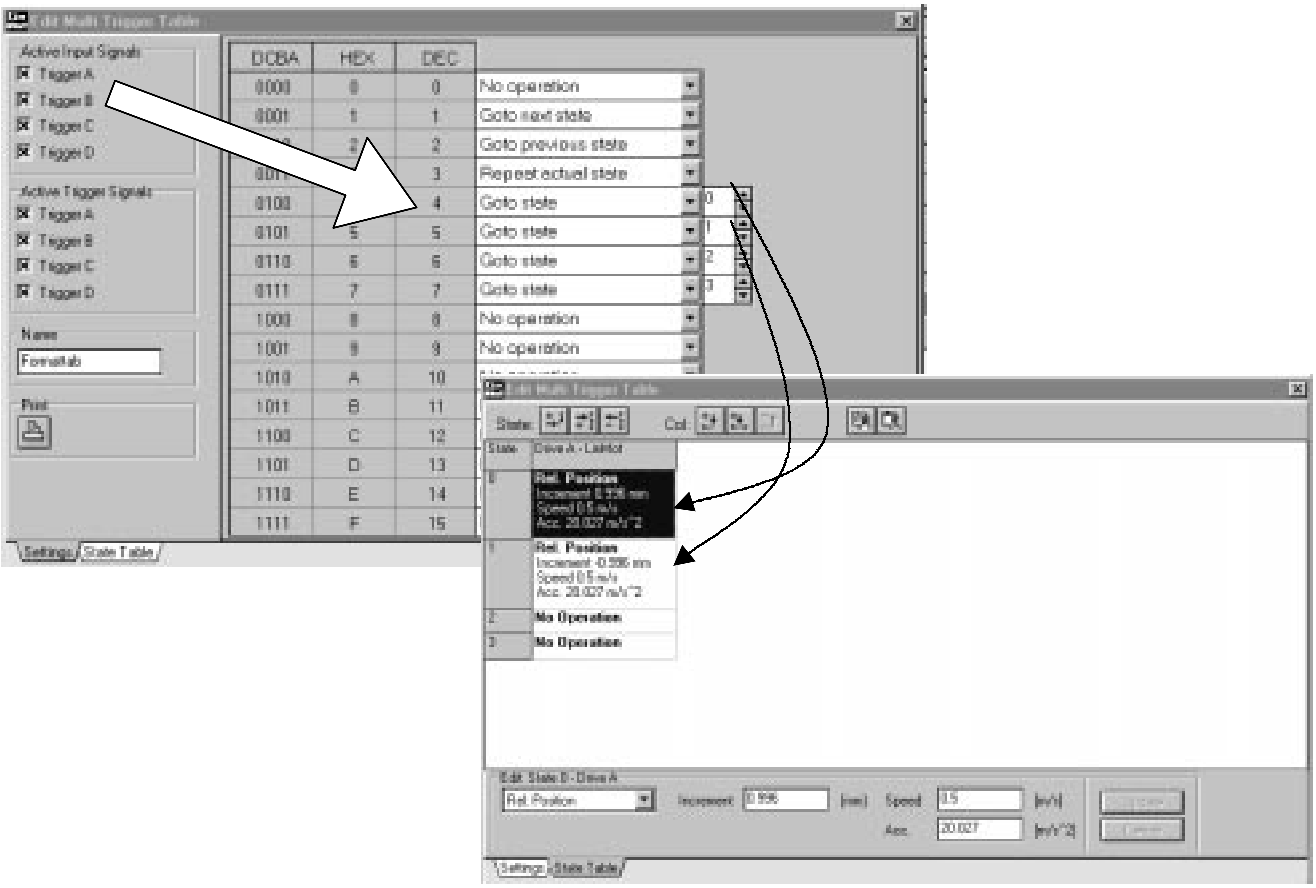
Create a multitrigger table which defines the relative movement (steps) forwards and backwards (state 0 and 1).

1. Turn on multitrigger functionality



2. Adjust jitter filter

3. Create multitrigger table (use Curve Inspector)



It is possible to define steps with different increments so that very flexible solutions are possible.

10. Teach-In procedure (MT-Mode)
Roboter and handling applications with teach-in

Task description

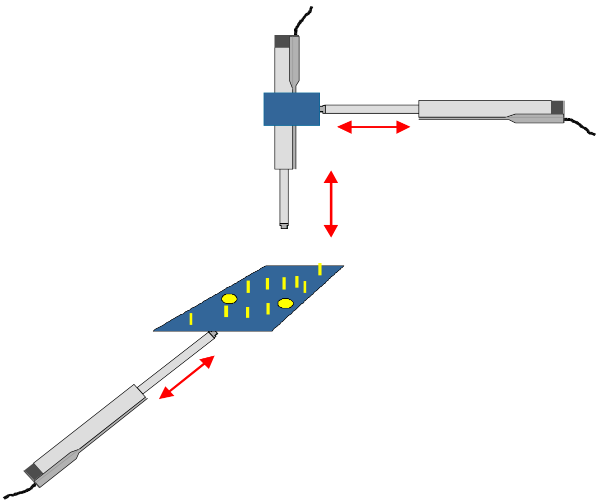
In an automation mechanism different positions must be programmed. The Teach-In procedures are used for the specification of the values.

(For practice the teach-in positions are written below

Stop outside 75 mm
Stop inside 20 mm
Position 1 33 mm
Position 2 65 mm

Movements to the stops: 0.3 m/s and10 m/s^2
Movements to position 1 and 2: 1.8 m/s und 80 m/s^2

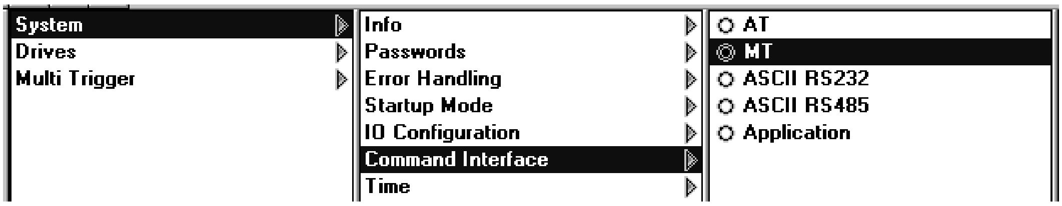
Use a multitrigger electronic and a small PLC with 4 digital outputs.



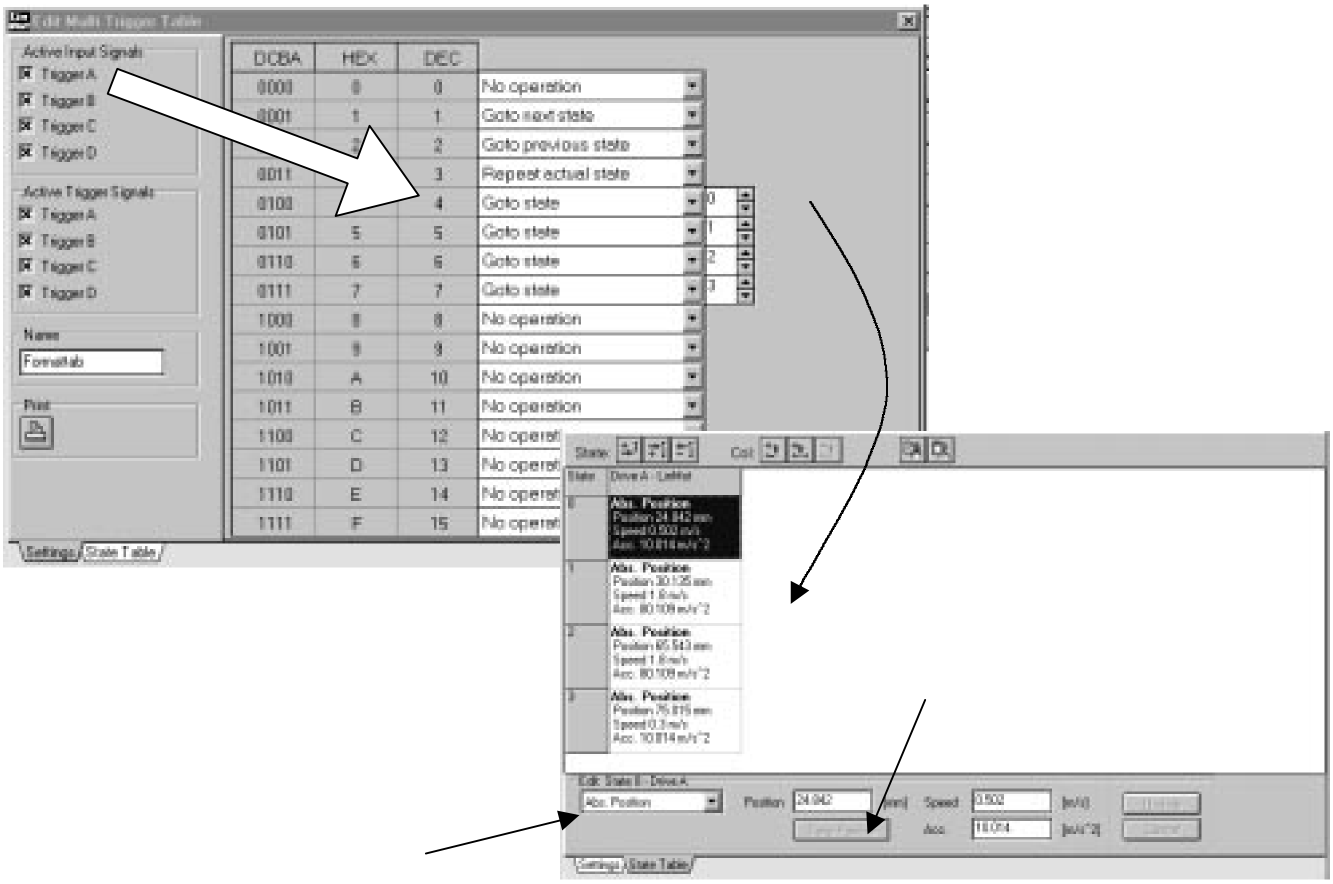
Solution

A multi-trigger table is created, in which the position with the ' Take position ' function are read in. In addition, electronics switches on and off after the initialization over the RUN button. Afterwards the slider can be moved freely and the positions can be read in.

1. Switch on multitrigger functionality



3. Create multitrigger table



11. End position feedback (MT-Mode)
Monitoring of the end position

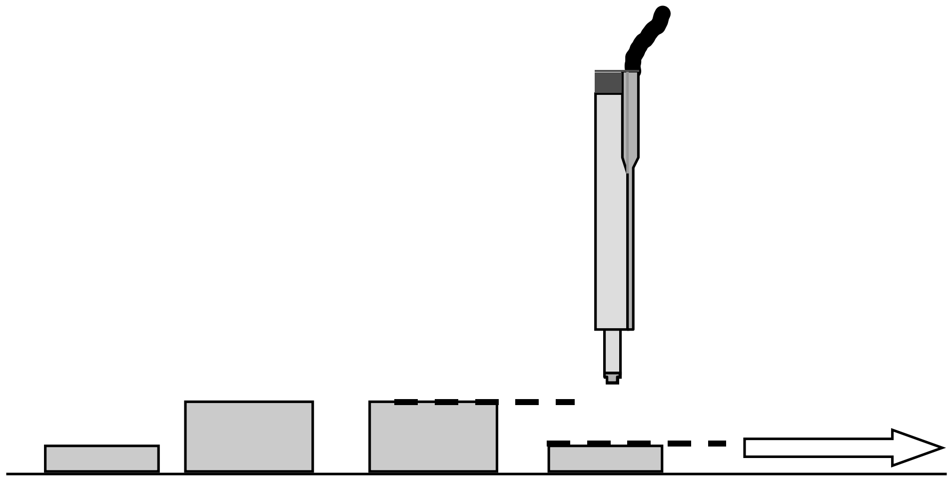
Task description

In an automation mechanism small and large parts are to be installed. For the controlling of the machine the superordinate control unit needs in each case a feedback signal, as soon as the linear motors has finished its movement.

Strokes and parameters:

Small parts:	20 mm to 80 mm	v_{max}= 1.5 m/s	a_{max}:= 50 m/s^2
Big parts:	35 mm to 65 mm	$_{max}$= 1.0 m/s	a_{max}:= 20 m/s^2

Use a multitrigger electronic unit.

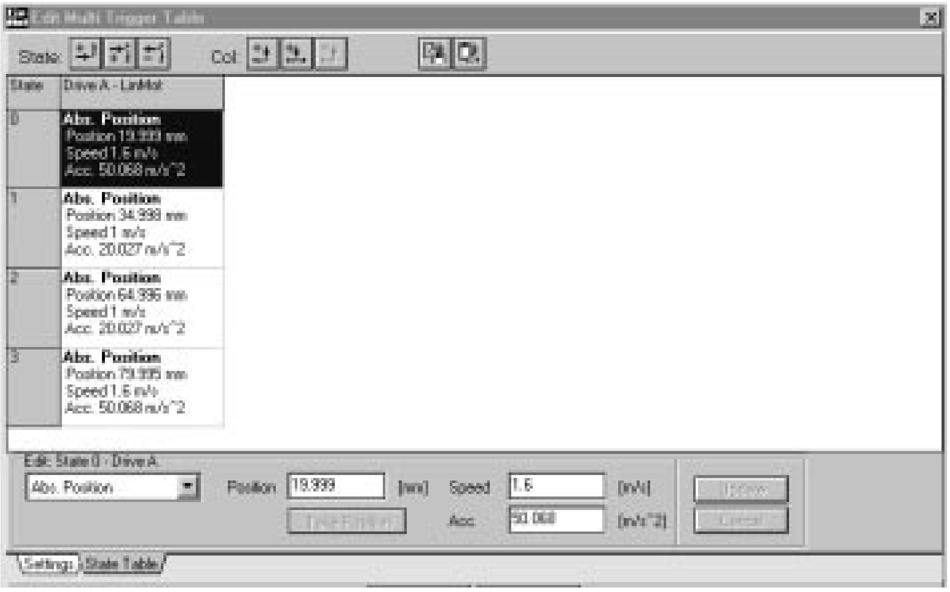


Solution

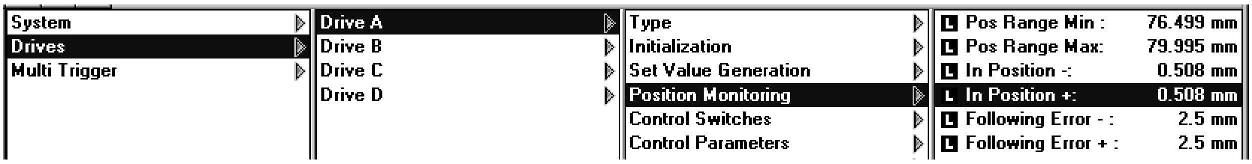
Create a multitrigger table and program the positions into 4 states.

1. Multitrigger table with:

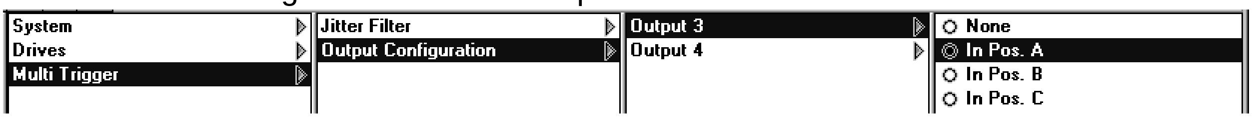
Position 0 (State 0):	20mm	v_{max}= 1.5 m/s	a_{max}:= 50 m/s^2
Position 1 (State 2):	35mm	v_{max}= 1.0 m/s	a_{max}:= 20 m/s^2
Position 3 (State 3):	65mm	v_{max}= 1.0 m/s	a_{max}:= 20 m/s^2
Position 4 (State 4):	20mm	v_{max}= 1.5 m/s	a_{max}:= 50 m/s^2



2. Adjust ‚In Position'Signal



3. Link 'In Position' signal of drive A to output 3



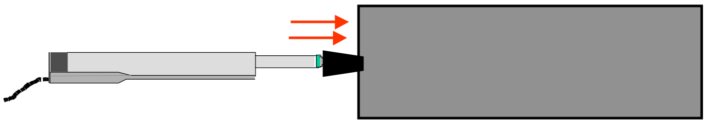
Remark: Compare hardware configuration (manual chapter 4.8.1). Output 3 must be an output and not be configured as a relay driver.

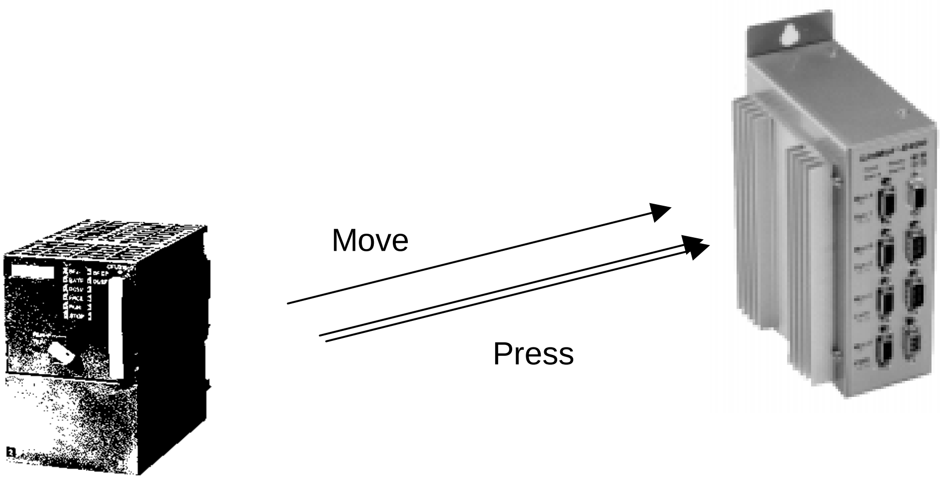
12. PLC/PC controls force
Press part into form

Task description
In an automation mechanism an assembly part is to be moved to a certain position. Subsequently, the moved part must be pressed in.

Strokes and parameters:
Stroke: 20 to 80 mm, v:=1.6 m/s, a:= 50 m/s^2 , force:= 100%
Force to press: ca. 15% of maximum force

Use MT-Electronic unit

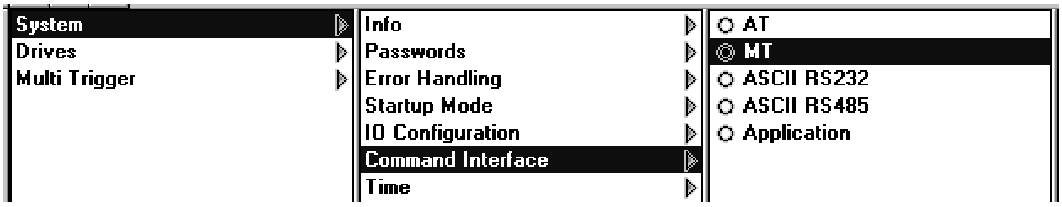




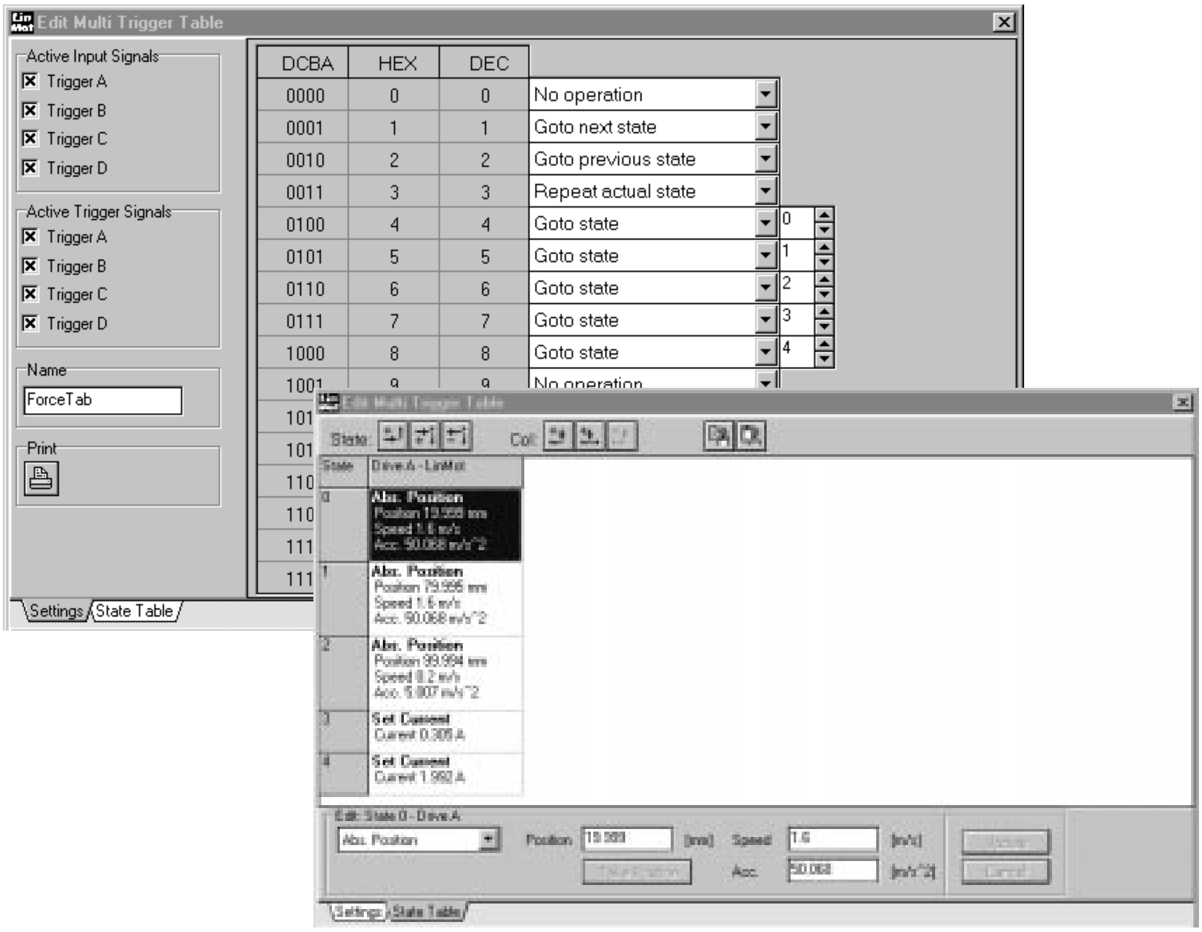
Solution

Using multitrigger, the force can be programmed on-line. The basic idea consists in reducing the force to 15 % of its original value after the part is moved to position. Then move to a position behind of the form. The result will be that the motor will be blocked through the form and the force will go up to maximum (now 15%) and press the part into the form. (Make sure that the I-parameter of the PID-controller is switched on)

1. Switch on multitrigger functionality



2. Create multitrigger table with positions and force limitations



Sequence: State 0 → State 1 → State 3 → State 2 → State 3 → State 4 → State 0 …

13. Unlimited number of steps (stepper motor) Stepper motor continuously rotating

Task description

A stepper motor is used in an automated mechanism. The number of revolutions in the same direction is unlimited. (The number of steps is limited in the LinMot® SW !) ???.

Stepper Motor: 1.8°/step

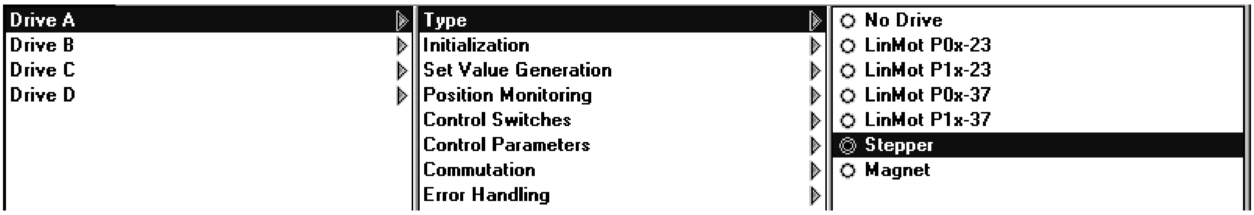
(This is similar to if linear motors with strokes longer than 1260 mm are used. Moving the 'Home Position' enables to run longer movements)

Solution

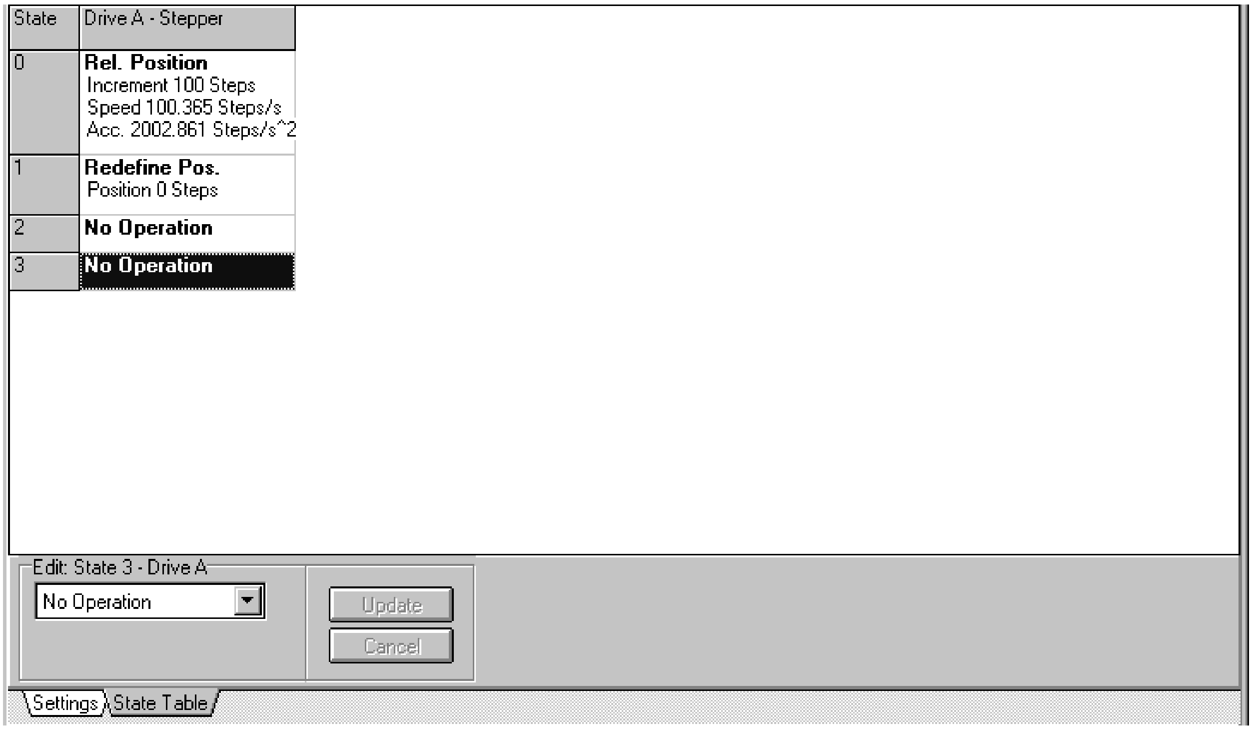
Serial interfacing (RS-232):
After each movement use the command !ZD, which resets the counter to zero.

Multitrigger-electronic

1. Link Drive A to stepper motor



2. Create multitrigger table



State 0 turns 180 °
State 1 reset the counter to 0

14. Multiple axle application
Handling machine with round table

Task description

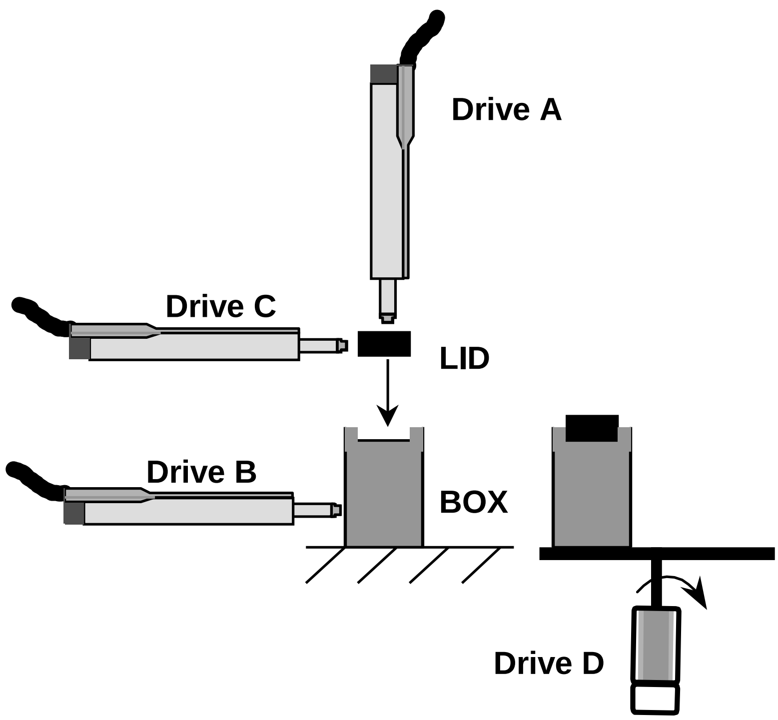
In an automated mechanism a lid is to be placed and pressed onto a box. Drives B and C are pushing the box and the lid into position. Drive A will press the lid onto the box using a profile. After this procedure the box will be moved on the round table (incremental movement). Drives A, B and C are going back to the start position, Drive D (stepper motor) turns 180°.

Drive A: P01-37x240 type
using profiles 'Point to Point': 30 mm to 100mm in about 60 ms
100 mm back to 30 mm in ca 180 ms

Drive B: Push box: 10 mm to 50 mm (2 m/s and 50 m/s2)
Push box another 10 mm to the table (0.1 m/s and 1.9 m/s^2)

Drive C: Position lid: 10 mm to 40 mm (2 m/s and 60 m/s^2)

Drive D: Stepper motor with 1.8°/step

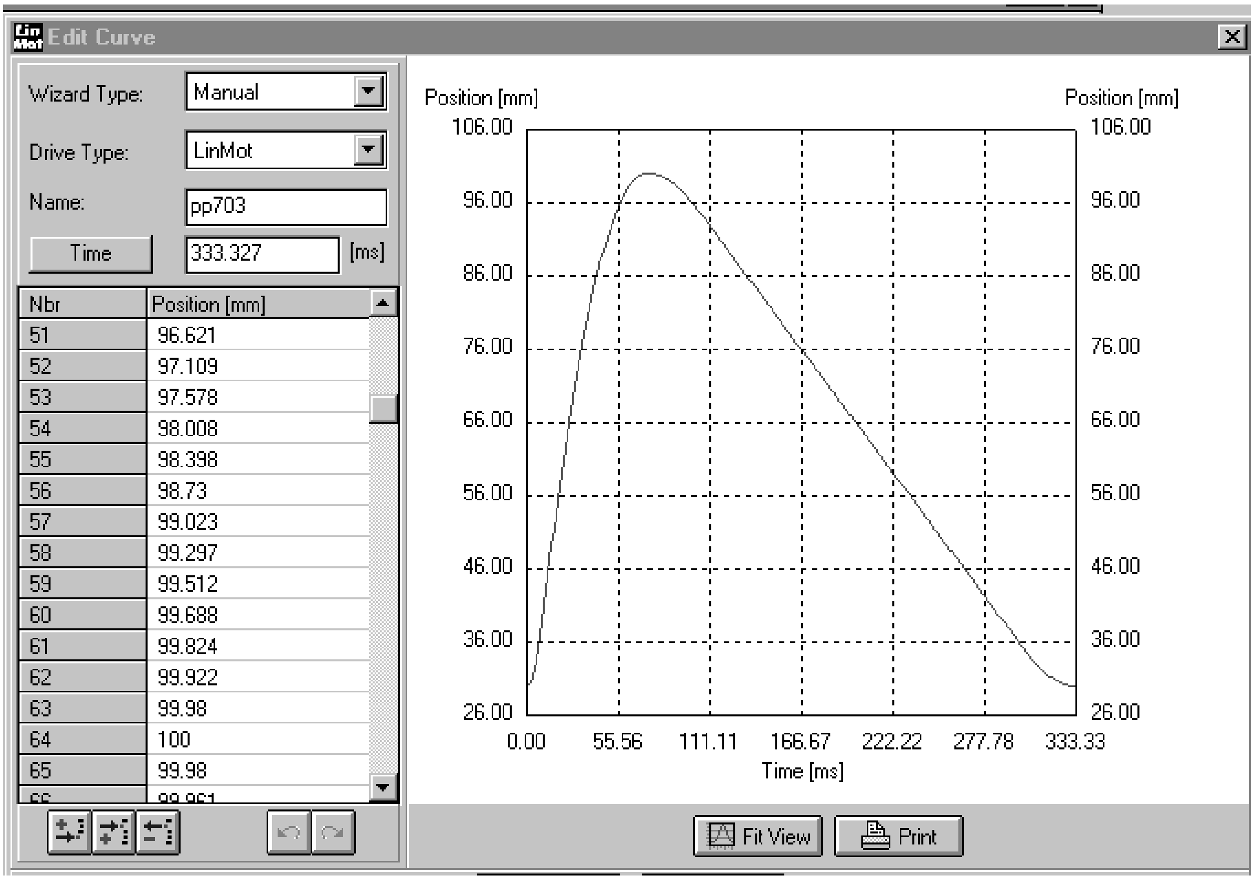


Solution

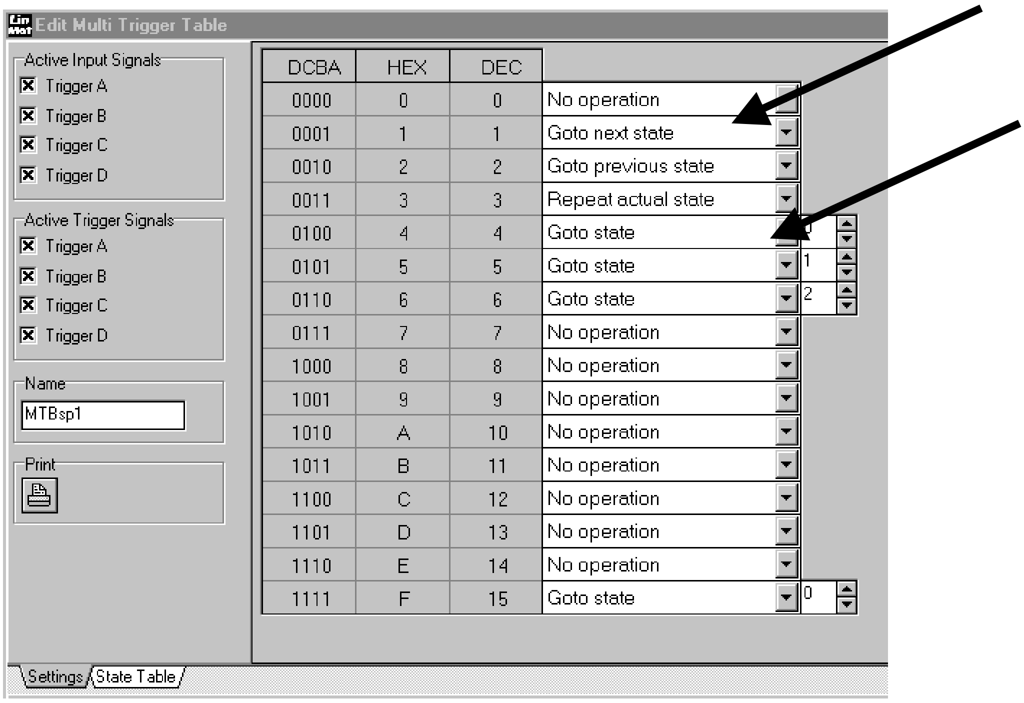
1. Select multitrigger mode

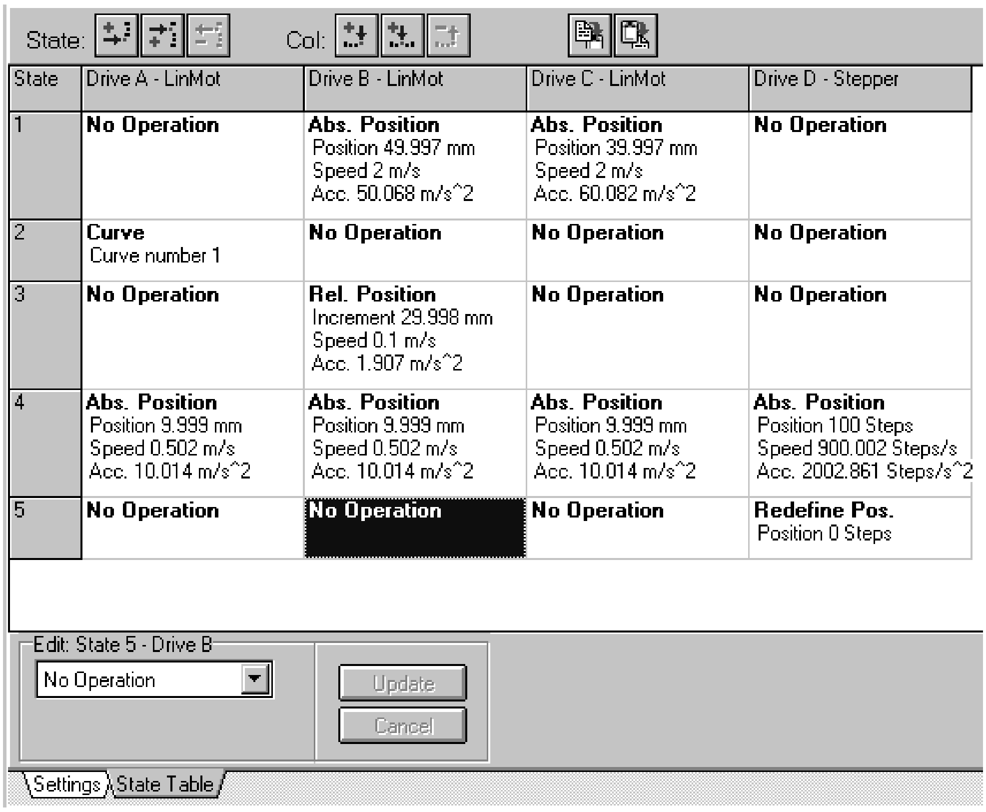
2. Select drives

3. Create profile (curve) for drive A. (create two curves and join them together)



4. Create multitrigger table





Sequence: State 0, next state (1), next state (2), next state (3), next state (4), next state (5), state 0

15. RS-232 interfacing
Press part into form

Task description

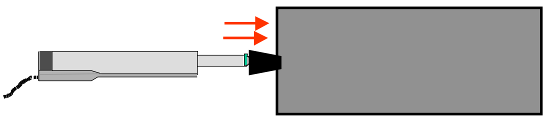
In an automated mechanism an assembly part is to be moved to a certain position. Subsequently, the moved part must be pressed in.

Strokes and parameters:

Stroke: 20 to 80 mm, v:=1.6 m/s, a:= 50 m/s^2, force:= 100%

Force to press: ca 15% of maximum force

Use RS-232 interface technology



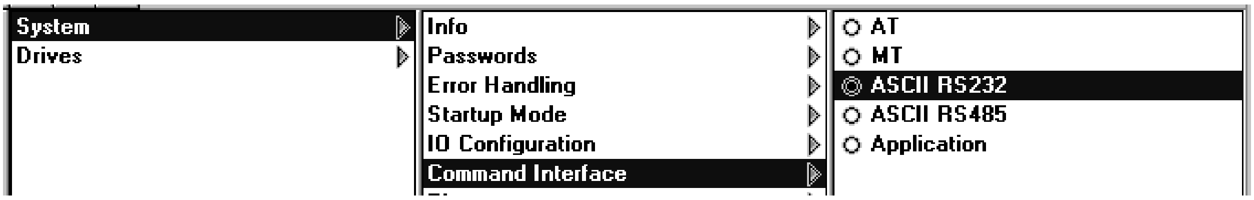
Sequence

Limit velocity to 1.6 m/s
Limit acceleration to 50 m/s2
Move to position 80 mm
Request and check actual position
Reduce force (current) to 15%
Increment position by 10 mm
Move to position 20 mm
Increase force to 100 %

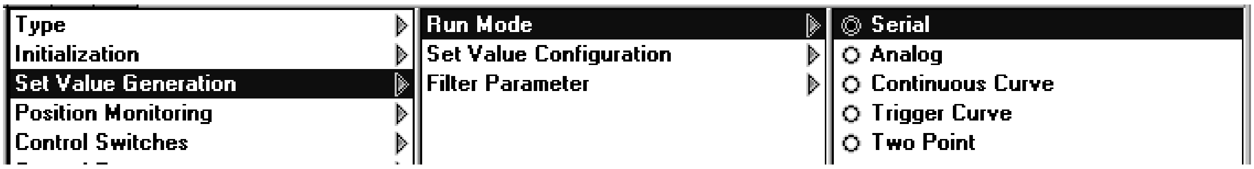
Solution

1. Check button position of your electronic unit: RS-232 needs ID1=0, ID0=1 (see manual R1.0 and manual R1.2), In this example the electronic unit has the ID nr. 1.

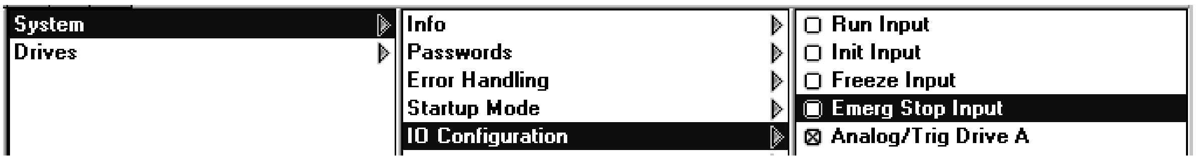
2. Set serial mode for the system with *LinMot®* Talk Mit *LinMot®*



3. Set serial mode for Drive A with *LinMot®* Talk

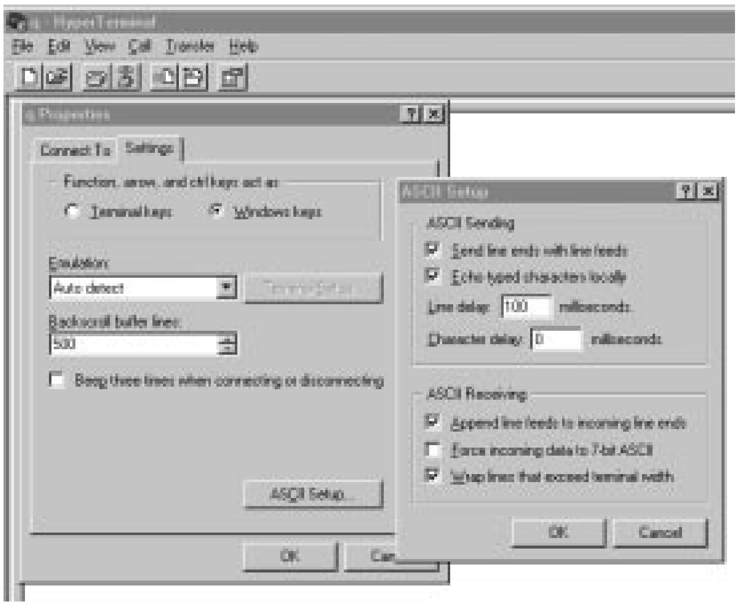


4. Disable all inputs. Controlling will be done only by RS-232 (in this example)



5. Shut down *LinMot®* Talk (→ interface will be ready for RS-232 direct control)

6. Log in using a communication program of your computer (e.g. Hyperterminal 9600 Baud). You will find an example in the folder ‚examples' of LinMot® Talk, which configure your communication port (use ASCII_C1 for COM1 and ASCII_C2 for COM2).



7. Ask scaling factor of your electronic unit ???

Command	Comment
!GS1	Check communication
#R	OK
!PIA	Request resolution of position
#19531250	19,0735 um
!VIA	Request resolution of velocity
#190735	0,190735 um/s
!AIA	Request resolution of acceleration
#238419	0.238 m/s^2
!CI1	Request resolution of current
#23438	23,438 mA

8. Scale the values

Position 20 mm → 1049
Position 80 mm → 4194
Position increment 10 mm → 524

Velocity 1.6 m/s →8400
Acceleration 50 m/s2 →210
Current 2 A →85
15% current → 13

9. Send commands to electronic unit

!SI-1 !SI-1	Switch electronic from 'Wait' (disabled) to "Enable". This procedure is only necessary if you are not in the 'auto start' mode (selectable by LinMot® talk)
!SI+1	Initiate
!SR+1	Select Run mode
#	

!SV8400A #	Set max velocity
!SA250A #	Set max. acceleration
!SC85A #	Set Current (force) 100% (2A)

!SP4049A #	Move to position 80 mm
!GPA #4049	Check position → ok

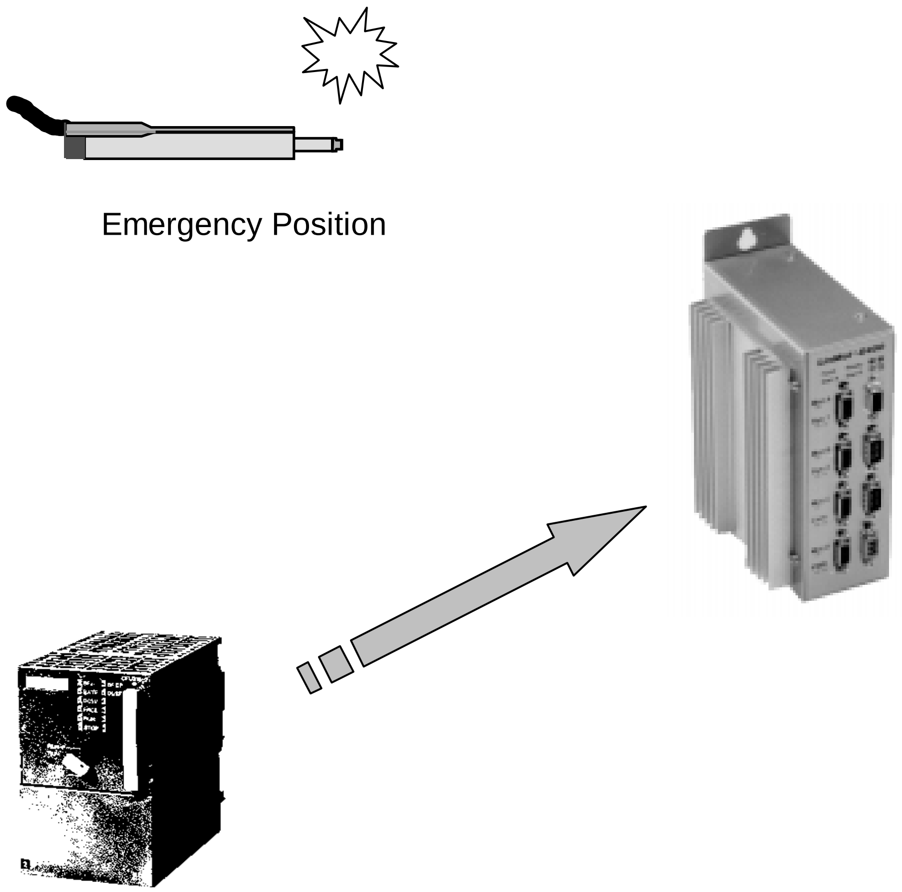
!SC13A #	Reduce force to 15%
!IP524A #	Increment position by 10 mm
!SP1049A #	Move back to 80 mm
!SC85A #	Increase force to 100 %

<u>Note:</u>
If you have problems with switching between LinMot® talk and RS-232 communication just switch off and re-start the electronic.

16. Stop situations
Go to special stop position

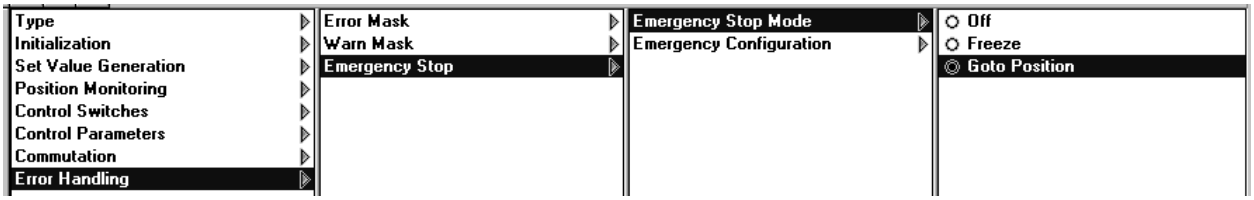
Task description

In a machine it is required that the linear motor for safety reasons withdraws itself to a so-called emergency stop position (14mm), as soon as an external stop signal is created.

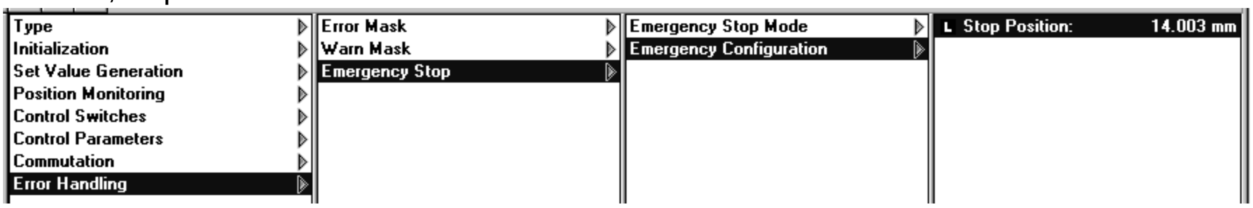


Solution

1. Enable ‘ ‚Go to Position‘ inside of the Error handling mask of the Drive



2. Set the ‚Stop Position‘ value



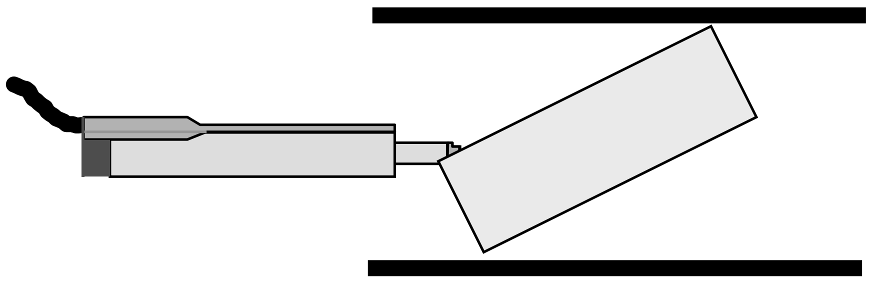
17. Check whether movement space is free
Check if any blocked package are in front of the motor

Task description

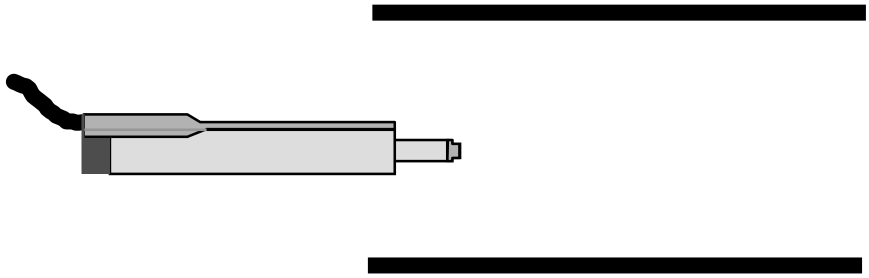
When starting the machine it is to be checked whether the movement space in front of the motor is free. Often it occurs the fact that a package in the machine blocked itself or that someone left an object such as a screw driver inside of the machine. In this case an error message is to be generated, so that the machine fails to start.

Room of movement in front of the motor: 80 mm
Check room with max. velocity of 25 mm/s
Reduce force to 75% during checking
Afterwards go to initial position 10 mm

Situation: Package is blocked



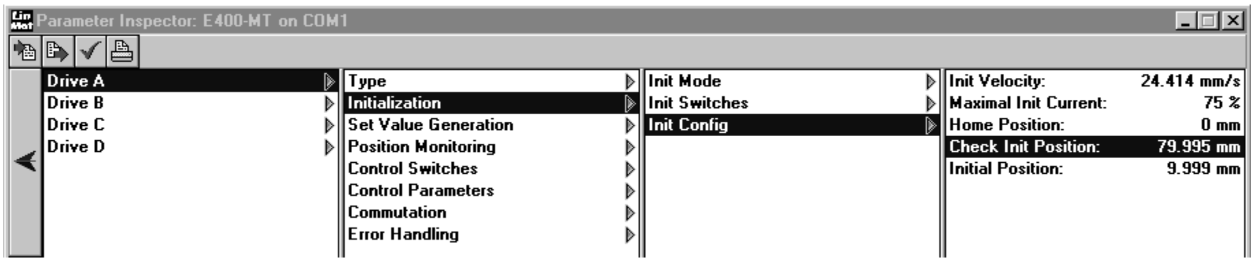
Situation: Room is free



Additional question: What is the parameter ‚Home Position' for?

Solution

1. During the initialization (homing) it's possible to check the room in front of the motor → set the parameters



<u>Answer to the additional question:</u>
After the homing procedure the 'home position' can be moved as it is convenient for the application. In particular, if the max stroke is longer than 630 mm, the homing position must often be shifted to be able to run between –630mm and +630mm.

18. Application ‘Jog’
Remote control of LinMot® with buttons

Task description

People would like to operate a LinMot® linear motor by remote control using three buttons. One button is used to move the slider ‘out’, a second button to move it ‘in’ and third button for fast movement.

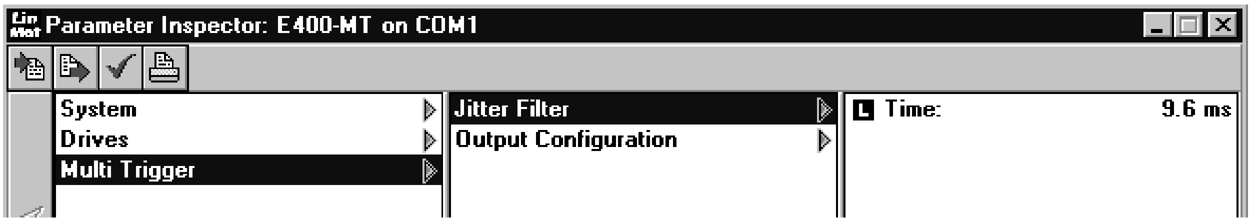
Button A: Slider move ‘out’ with v=0.01 m/s

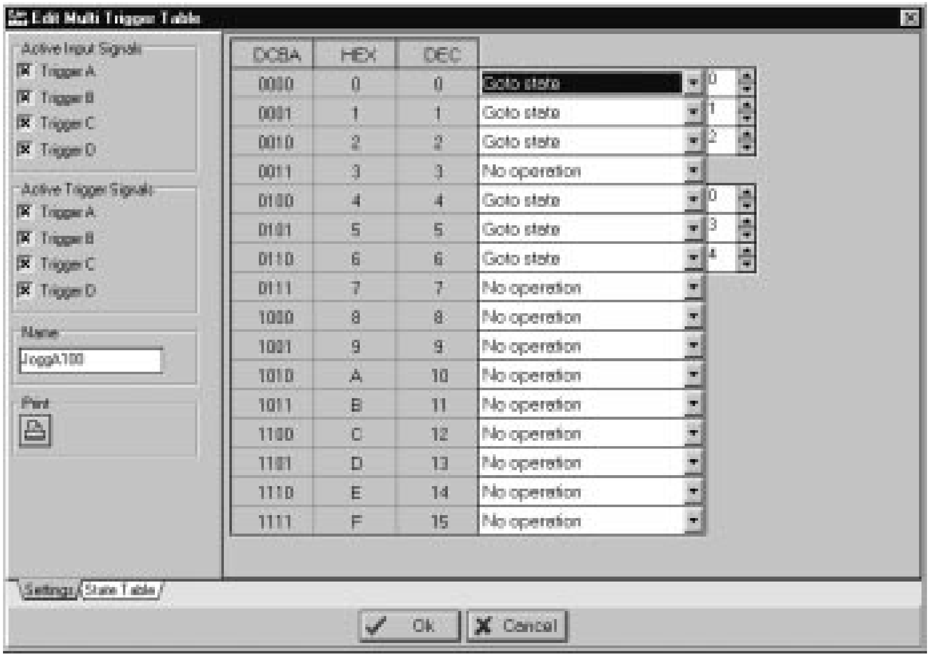
Button B: Slider move ‘in’ with v=0.01 m/s

Button C: Change speed to 0.2 m/s instead of 0.01 m/s if operated simultaneously with button A or B

Solution

LinMot® Multitrigger electronic unit Exxx-MT: The buttons A, B and C are directly connected to the trigger inputs A, B and C. Set Jitter filter to about 10 ms to get an immediate answer if buttons are pressed.



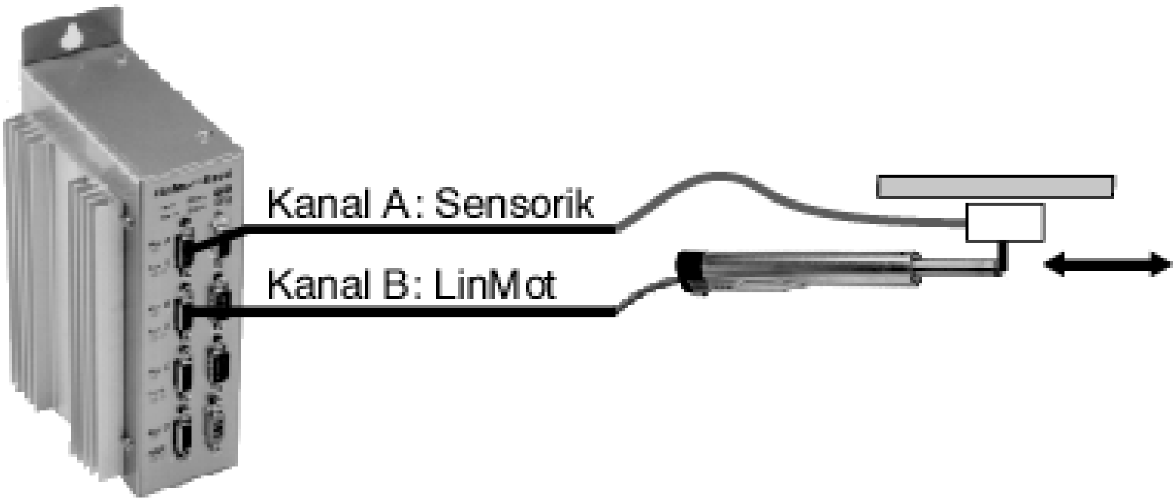


19. Positioning with 10 µm repeatability
Configuration with external position sensing

On a printing machine a film is to be positioned with a repeat accuracy of 10 µm.

With LinMot P linear motors the repeatability of the internal position sensing is 100 µm. To raise this to 10 µm therefore, external sensing is employed.

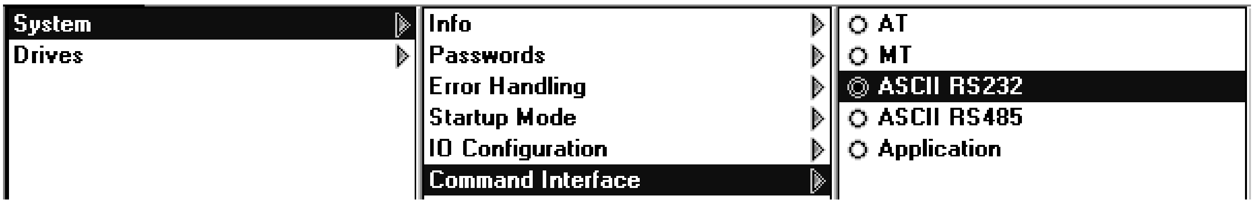
Available are only an E200-AT, an external sensor system (consisting of measuring head, tape with 1 mm pole distance and amplifier adapter) and a linear motor P01–23x160/0x140. The target position is given via RS232.



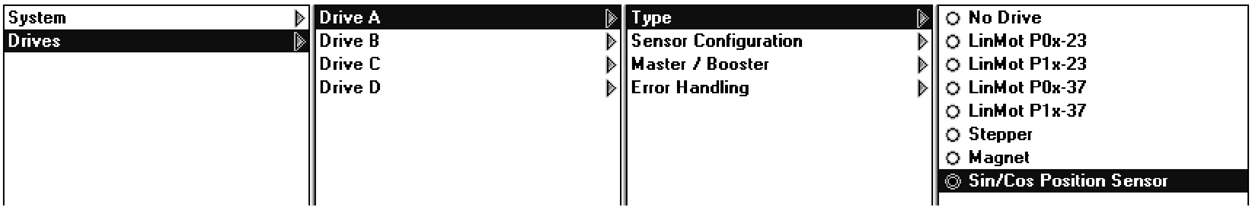
Solution

On motor channel A there is the external sensing for configuration, and on motor channel B the linear motor.

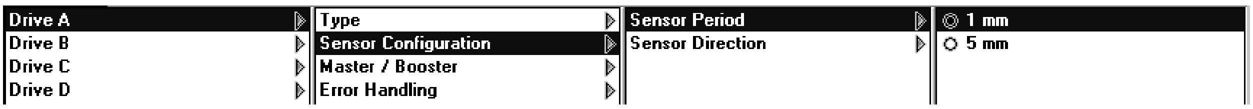
1. Adjust for RS232 interface.
   The target position is given on channel B via RS232 protocol.



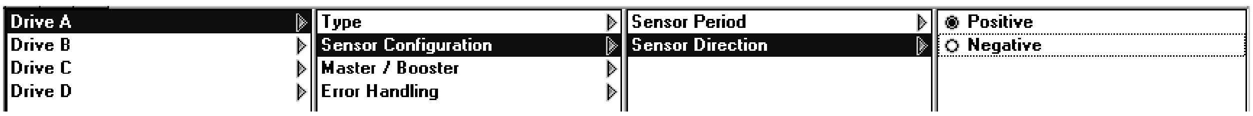
2. Set position sensor to motor channel A.



3. Adjust sensor period to 1 mm.

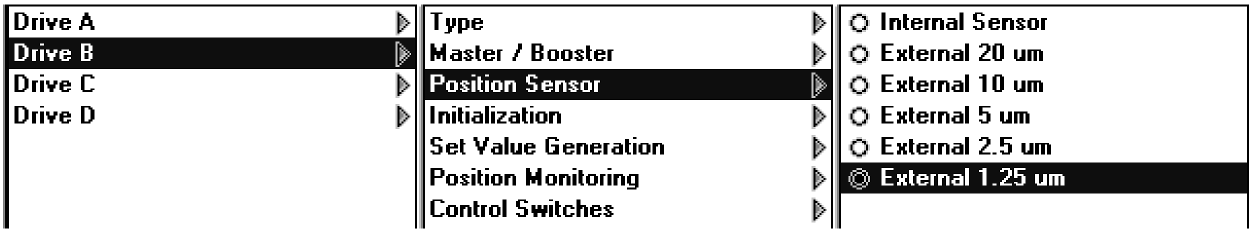


4. Set sensor direction to „positive“; master/booster must be at „master“.

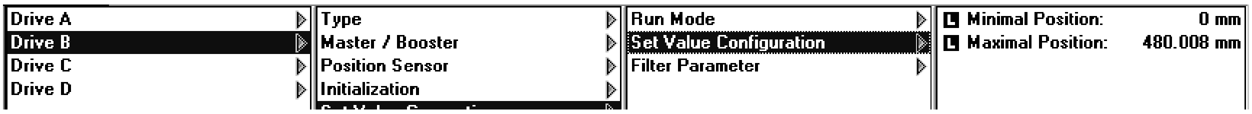


5. Set linear motor P0x23 to motor channel B and configure as master.

6. Adjust external sensor resolution to 1.25 µm.



7. All parameters defining a position are given another scaling factor on account of the external sensing. For 1.25 µm resolution, all position values must be entered 16 times bigger than is wanted, i.e. 480 mm must be entered if the maximum position is to be fixed at 30 mm. The same applies to position targeting via RS232.



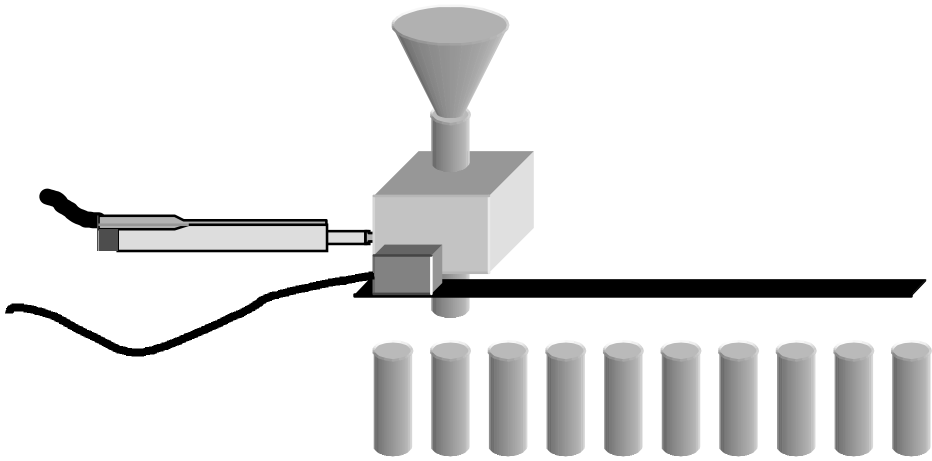
Note: With external sensing the values of the PID controller parameters may be raised on the strength of the higher resolution.

20. Improved linearity with external position sensing
Configuring the external position sensing

On a handling machine any position must be moved into with an absolute accuracy of 0.05 mm. Maximum travel is 920 mm. The target position is to be set via the serial interface RS232.

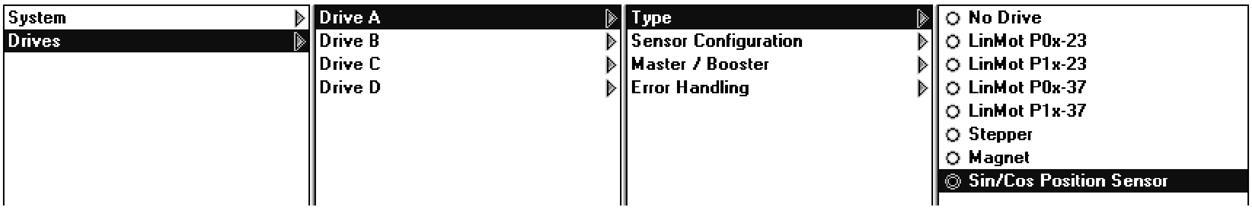
Owing to the restricted linearity, the internal position sensing of the linear motor is inadequate for attaining an absolute accuracy of 0.05 mm. Consequently external position sensing is employed.

Available are an E200-AT, a sensor system (consisting of measuring head, magnetic tape with 5 mm pole distance and amplifier adapter) and a linear motor
P01-37x240/860x1060.

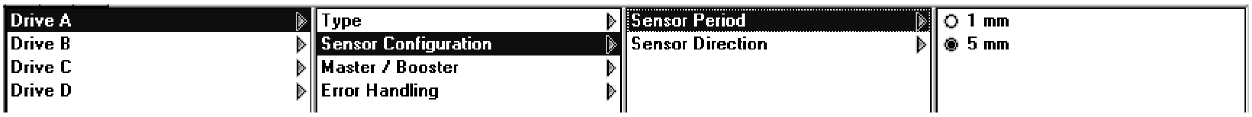


Solution

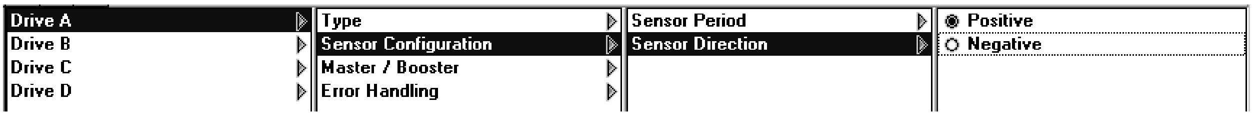
1. Set position sensor to motor channel A.



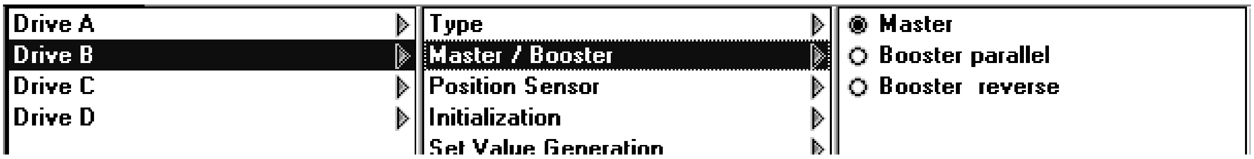
2. Adjust sensor period to 5 mm.



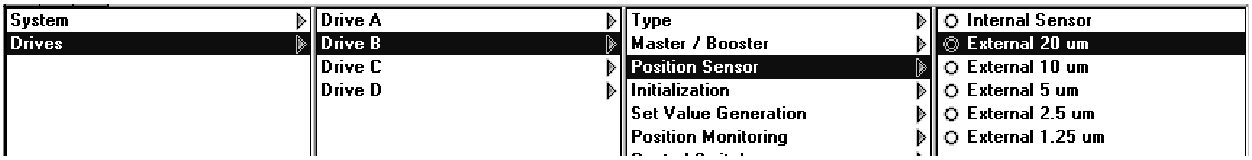
3. Set sensor direction to „positive“; master/booster must be at „master“.



4. Set linear motor P0x37 as master onto motor channel B.



5. Adjust external sensor resolution 20 µm.



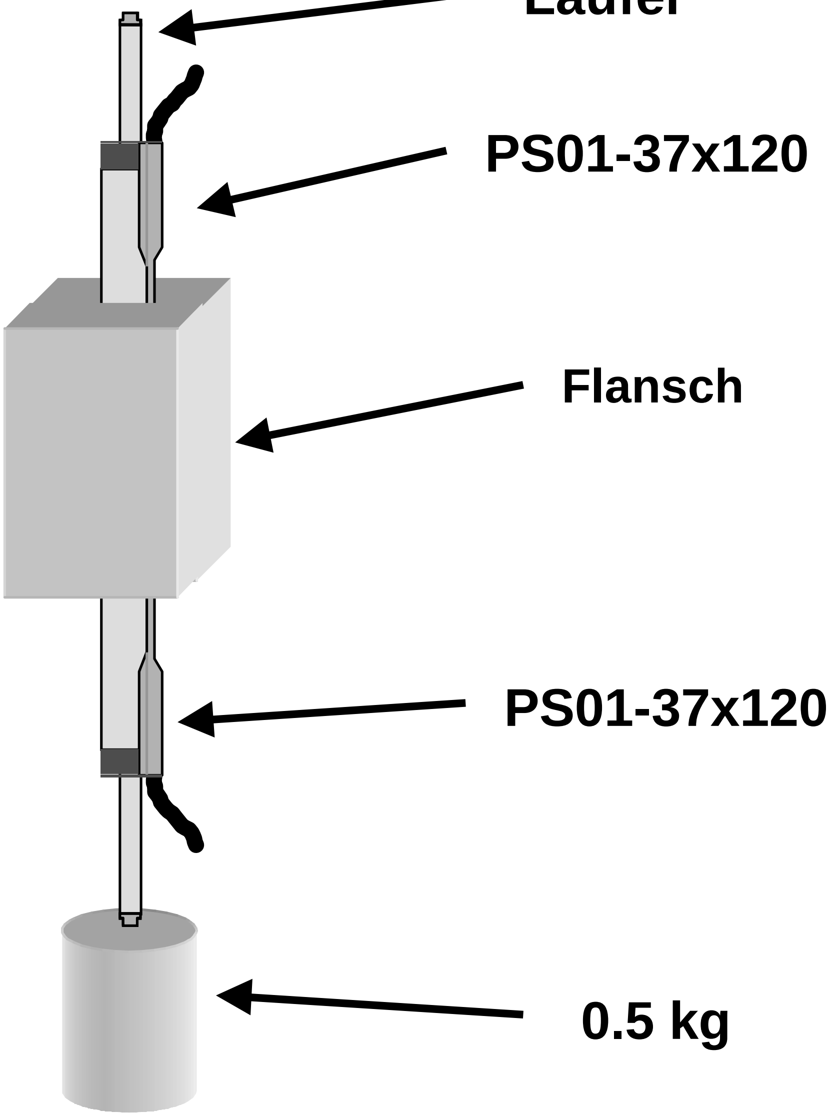
21. Operating 2 motors in parallel
Force multiplication to raise the dynamics

A load mass of 0.5 kg is to be raised vertically by 480 mm within 210 ms.

The peak force of a single P01-37x120 linear motor is not enough to perform such a dynamic motion. Though one linear motor P01-37x240 can deliver this peak force, it cannot reach the maximum speed. Therefore two linear drives of type P01-37x120 are connected in series.

Available are an E2000-AT, two P01-37x120 and one PL01-20x1000/920 .

Note: The two motors move a common slider and are placed in opposite directions. A common flange assures mechanical parallelism.

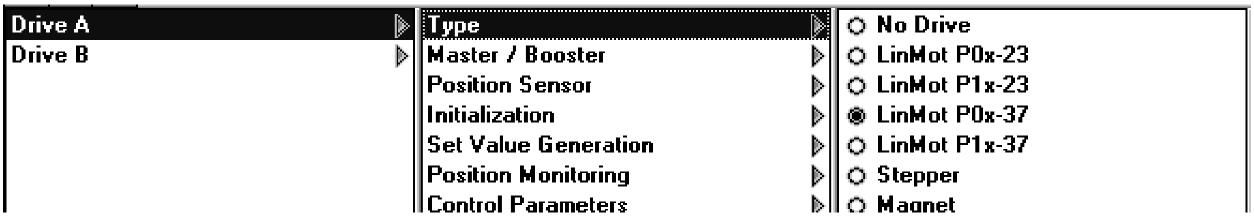


Solution

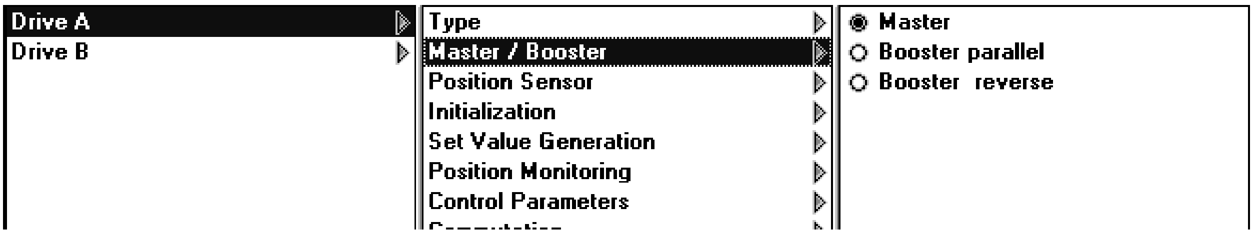
The target position is entered on the master (in this case motor channel A). The second motor operates in booster mode as amplifier doubling the force. The target position is given using ‚two-point mode‘.

1. Adjust maximum speed to 3.5 m/s, acceleration to 50 m/s^2. With equation F =m*a (where m = load mass + slider mass) the theoretical dynamic force amounts to 135 N. Holding force is 27 N.

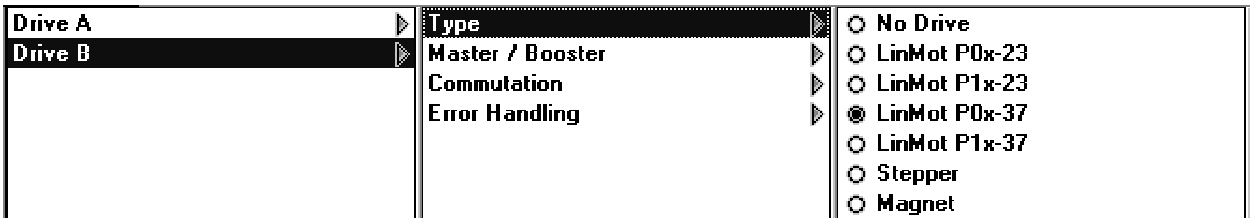
2. Set motor type for motor channel A as Lin Mot P0x-37



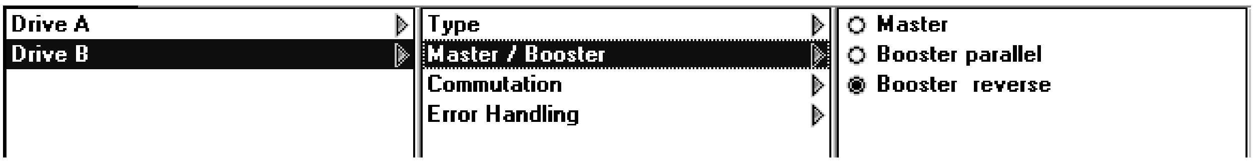
3. Set motor on motor channel as master.



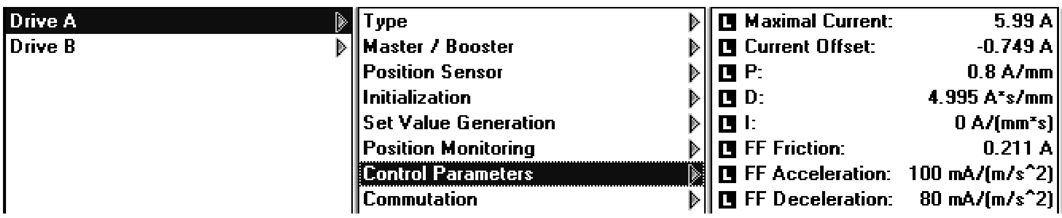
4. Set motor type for motor channel B as LinMot P0x-37.



5. Set linear motor on motor channel B as „booster reverse“.



6. Adjust controller.

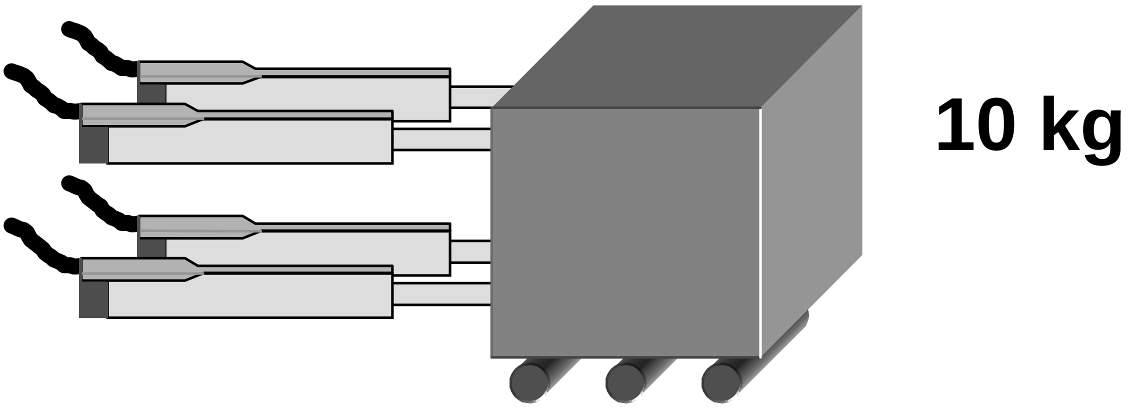


22. Operating 4 motors in parallel
Paralleling to raise the peak force

On an assembling facility a workpiece weighing 10 kg is to be moved 120 mm in 120 ms. Cycle time is 1 second.

The peak force of one P01-37x240 linear drive is insufficient for the acceleration needed. Several linear drives must therefore be operated in parallel.

Available are an E4000-AT, four P01-37x240/60x260.

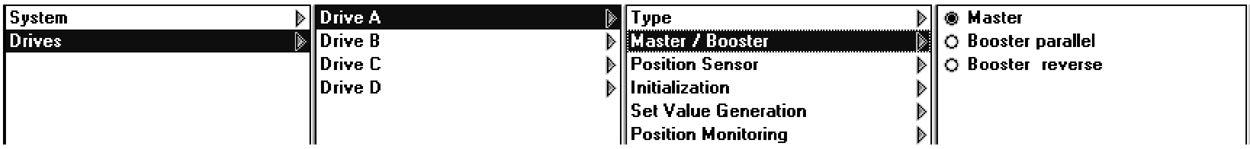


Solution

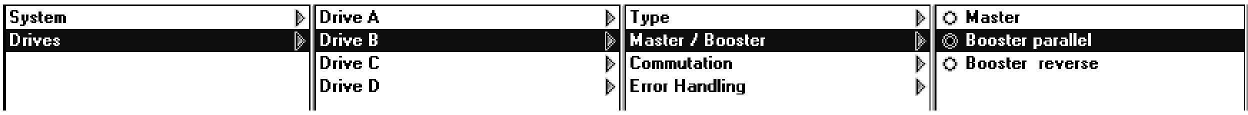
The task can be performed by the parallel operation of four P01-37x240/60x260, generating a total peak force of 800 N. To enable the motion to be performed, a maximum speed of 1.5 m/s and a maximum acceleration of 38 m/s^2 are needed.

1. Set motor type for chennels A, B, C and D as LinMot P0x-37.

2. Set motor type on channel A as master.



3. Set motor types on channels B, C, and D as paralleled boosters.



Note: The target position is given typically in two-point mode via motor channel A.

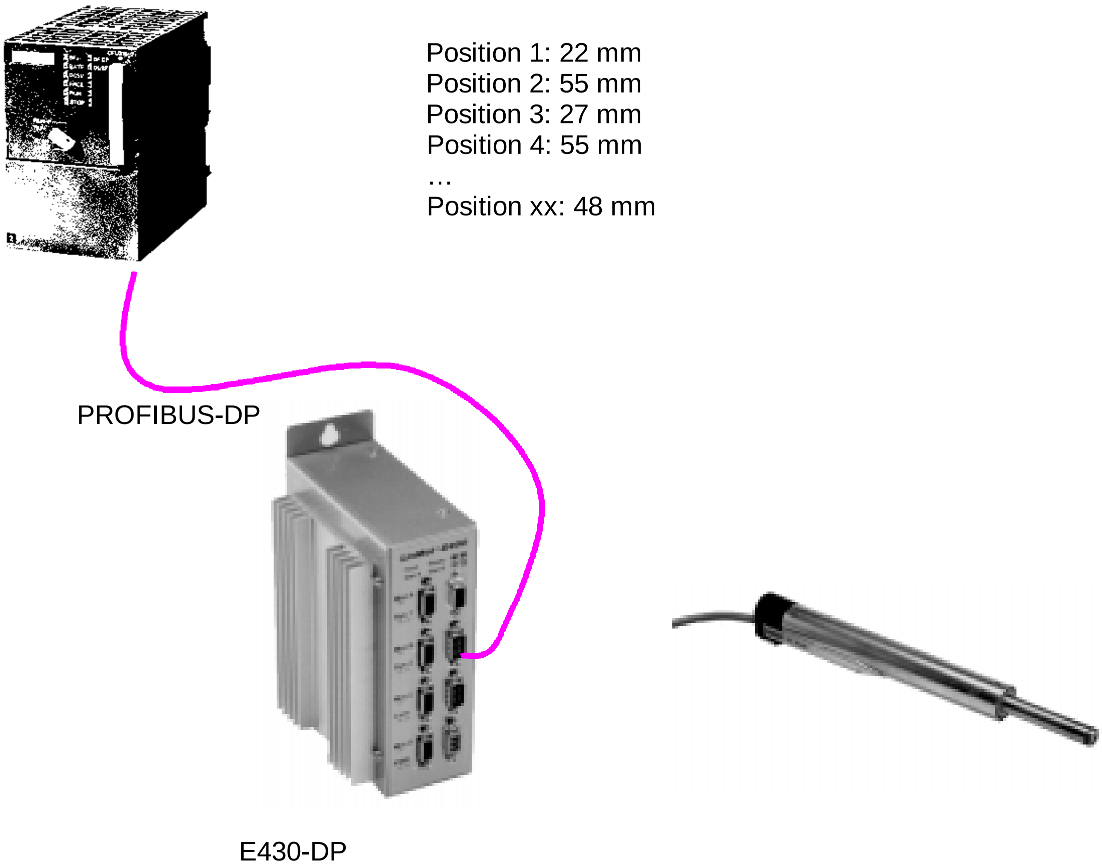
23. PLC/PC with PROFIBUS-DP master selection
Moving into any position

The task involved

A freely adjustable linear motion is needed for a laboratory facility. The movement is calculated on-line by a PC or a PLC and ranges between 20 mm and 70 mm. It must be possible to move into any position within this range. For safety reasons the acceleration must never exceed 75 m/s^2 nor the speed 1.6 m/s.

Supplementary requirement

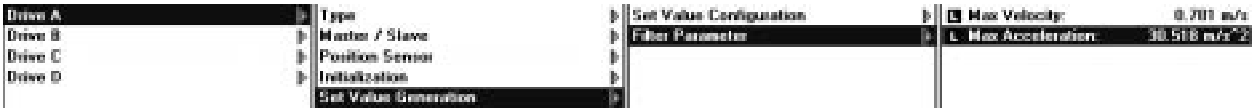
IIt must be possible to move into many freely selectable positions at will. Maximum speed must not exceed 0.2 m/s.



Solution

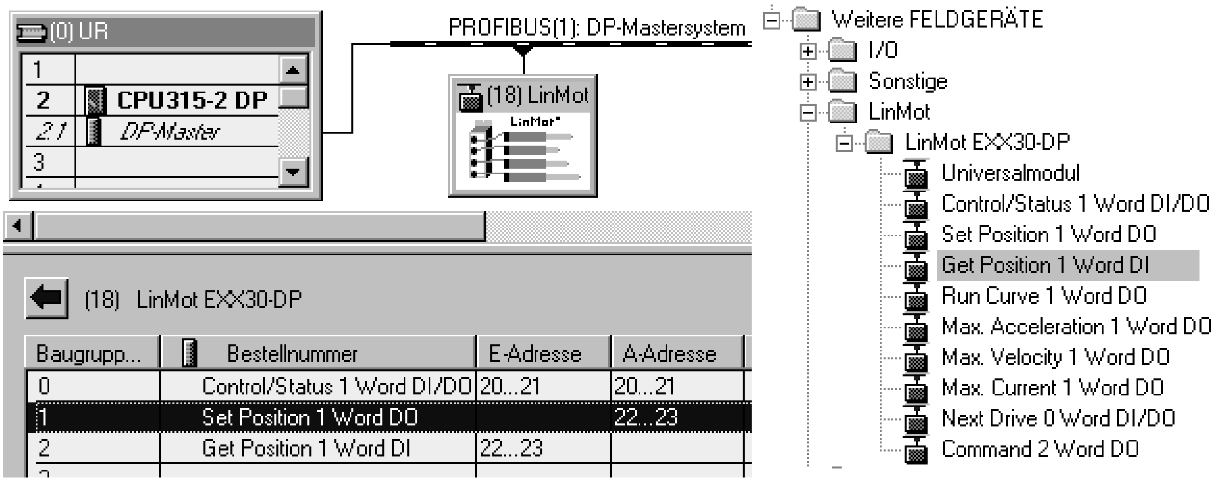
Position targeted via PROFIBUS-DP with speed and acceleration limited via LinTalk.

1. Speed and acceleration limited with LinTalk.



2. Read the GSD data file into the configuration software for the PLC. The file is entitled „linm00b6.gsd“ and is located in the subdirectory ..\GSD of LinTalk.

3. Tie the LinMot electronic unit into the bus system and configure the data to be exchanged, here taking as example a Siemens Simatic S7-315-2DP under STEP7.



4. After loading the configuration into the PLCl and linking this with the LinMot electronic unit according to standard, communication is taken up.

5. Initializing the motors is triggered by setting the „INIT-request“ bit in the control word. After the „WARNING pending“ bit (INIT not done) has changed to zero, the „INIT-request“ bit can be reset and the „RUN-request“ bit set. The LinMot electronic unit now changes into the RUN state and evaluate the values given in the „Set position“ module. The actual position of the LinMot may be read out in the „Get position“ module.

Variablentabelle1

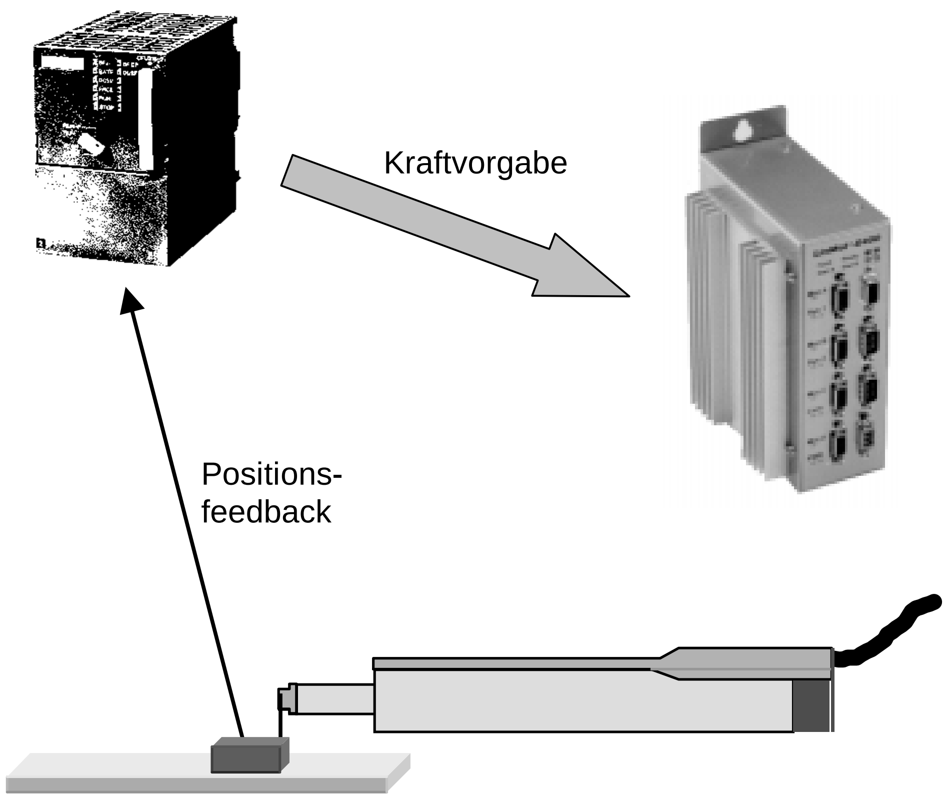
Operand	Symbol	Statusformat	Statuswert	Steuerwert
AW 20	"Control"	BIN	2#0000_0010_0000_0000	2#0000_0010_0000_0000
EW 20	"Status"	BIN	2#0000_0010_0011_0000	
AW 22	"Set Position"	DEZ	1024	1024
EW 22	"Get Position"	DEZ	1024	

The unit of the position is 19.53125 µm (in the above example 1024 is equivalent to exactly 20mm).

24. Control through force
Interface to a Delta Tau PMAC motion control board

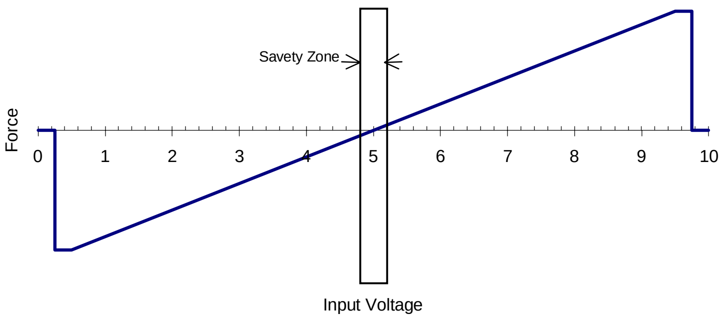
<u>The task involved</u>

The motion of a linear motor is to be controlled from an outside axis control board. The output of this is an analog control signal proportional to the force to be exerted (comparable to the torque setpoint with rotary motors). Used here as an example is a PMAC board of Delta Tau Data Systems Inc. .



Solution

An E1xxx-AT or E1xxx-MT-electronics with installed force control software is used. The force of the connected linear motor is adjusted by an analog signal (0-10V) at the „TRIG IN 1“ input. The diagram belows shows the U/F characteristic.

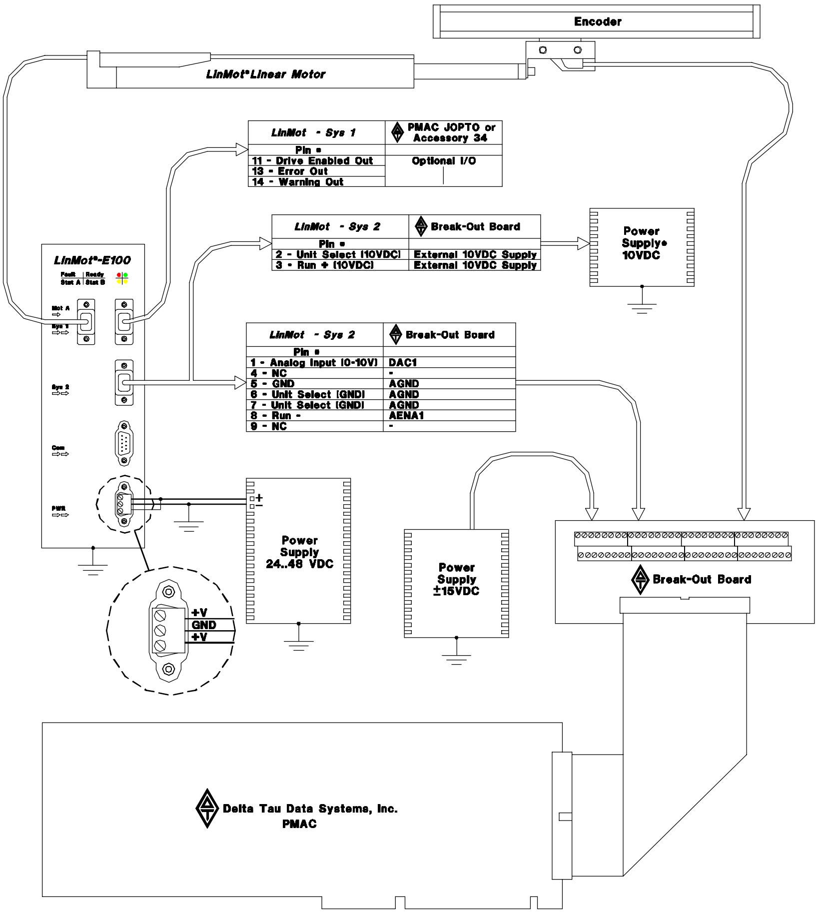


-/+10V control signals

The control signal from many motion control boards ranges within -/+10V. If the board cannot be adjisted for 0-10V operation, the signals may be conditioned with the LinMot ‚Breakout Module‘ and presented between 0-10V.

Voltages below 0.25 V or above 9.75 V cause the motor to cut out. This will prevent any uncontrolled motor movements if there is a cable break between the motion control board and the LinMot electronics.

To enable the position to be controlled, an external length measuring system must be attached to the linear motor. Its position signal is led straight to the motion control board. The position control is thus performed entirely by this board.
The diagram that follows shows the typical design of such a system with Delta Tau, which is reproduced here in slightly abbreviated form.



* Note: 10 VDC power supply common must be tied to PMAC's AGND for the drive to enable.

For further information the reader is referred to the application note of Delta Tau, which is reproduced here in slightly abbreviated form.

DELTA TAU
DATA SYSTEMS, INC.
NEW IDEAS IN MOTION . . .

APPLICATION NOTE.....

Using PMAC with *LinMot®* Linear Motors and Drive Units

LinMot® Force Control Unit
(*E100-AT and E1000-AT*)

Introduction

This application note describes how to connect and configure the Delta Tau PMAC (Programmable Multi Axis Controller) to control single or multiple *LinMot®* linear motor/drive systems. The PMAC will interface with *LinMot® E100-AT* and *E1000-AT Force Control Units*. The PMAC will require position feedback from an external sensor such as an encoder.

Overview

The *LinMot® Force Control Unit* utilizes a current/force loop which is commanded externally by an analog 0-10V reference signal from the PMAC. 0.25-5V input signals result in a negative force. 5-9.75V input signals result in a positive force. Zero force is at 5V.
The *Force Control Unit* implements a safety zone which is ±0.25V about zero force input. The drive will not operate unless the input voltage is within the safety zone when the enable signal becomes true. This prevents unintentional ejection of the slider

System Requirements (PMAC1)

A typical single axis linear motor system will require the following hardware:

1. One of the following Delta Tau Data Systems control boards:
    a) Mini-PMAC (2 axis)
    b) PMAC-PC(4 or 8 axix)
    c) PMAC-Lite (4 axis)
    d) PMAC 1.5 STD (4 or 8 axis)
    e) PMAC-VME (4 or 8 axis)

    Note: All PMAC control boards may be used in a standalone configuration if an external +5VDC power supply is provided.

2. One of the following Delta Tau Data Systems break-out boards per 4-axes:
    a) Accessory 8D (Phoenix terminal block with options)
    b) Accessory 8P (Phoenix terminal block)
    c) Accessory 8DP (D-sub connectors)
    d) Accessory 8DCE (CE Certified board, terminal block or D-sub)

3. *LinMot® E100-AT* or *E1000-AT with Force Control Software*
4. *LinMot® - P Linear Motor*
5. F eedback Device (encoder)
6. 24..48VDC Power supply for *LinMot® Force Control Unit*
7. 10 VDC Power supply (*LinMot®* drive input select)
8. ±15VDC Power supply for PMAC

System Requirements (PMAC2)

A typical single axis linear motor system will require the following hardware:

1. One of the following Delta Tau Data Systems control boards:
a) Mini-PMAC2 (2 axis)
b) PMAC2-PC (4 or 8 axis)
c) PMAC2-Lite (4 axis)
d) PMAC2-VME (4 or 8 axis)

Notes: 1. All PMAC control boards may be used in a standalone configuration if an external +5VDC power supply is provided.
2. PMAC2 Ultralite may be used with *LinMot*® motors and drives, contact Delta Tau Data Systems for more information.

2. Delta Tau Accessory 8E break-out board
3. *E100-AT* or *E1000-AT with Force Control Software*
4. *LinMot® - P Linear Motor*
5. Feedback Device (encoder)
6. 24..48VDC Power supply for *LinMot® Electronic Unit*
7. 10 VDC Power supply (*LinMot*® drive input select)
8. ±15VDC Power supply for Accessory 8E

PMAC Setup

In addition to normal setup and motor tuning (discussed in your PMAC User's Manual), some preliminary configuration will be required in order to setup PMAC to control the *LinMot*® drive unit.

I-Variables Settings

Ix29 Motor x Output – DAC Bias

Ix29 is PMAC's digital equivalent to an offset potentiometer. In conventional servo control applications the analog control signal is ±10V, 0V being zero force. The *LinMot® Force Control Unit* utilizes a unique control signal of 0-10V, 5V being zero force. With Ix29 we can easily shift PMAC's zero force output to 5V by setting it to 16,383 (units are DAC bits, 32,767 = 10V).

Ix69 Motor x Output Command (DAC) Limit

Ix69 defines the magnitude of the largest output that can be sent from the control loop. In compliance with Figure1, the maximum voltage output should be set to 4.75V. Voltages above this will cause the *LinMot® Force Control Unit* to set it's outputs equal to zero force when PMAC commands maximum force. Ix69 should be set to 15,564 (units are DAC bits, 32,767 = 10V).

Encoder Setup

Once you have completed wiring and preliminary setup as discussed above it will be necessary to verify proper feedback of the encoder. To do this we issue an open loop command for the appropriate motor and watch the position window. If a positive open loop command yields a positive position change, the encoder decode sense is correct. If however a positive open loop command yields a negative change in position, the encoder decode settings will need to be modified. Please refer to your PMAC Software manual for details. (I900, I905..I975 for PMAC1, I9n0 for PMAC2).

Example of open loop command for motor 1:
In the terminal window: #1O2 <CR>

This would result in a positive output of 2 percent of the maximum allowable output set by I169 for motor 1.

> *CAUTION*: Damage to the equipment or personal injury may result from improper use of the open loop command. The user should gradually increase the value until motion is detected and then immediately kill the motor with a CTRL “K”. Starting with a value of 1% is not unrealistic.

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PMAC User’s Manual for instructions on how to tune a motor using PMAC.

Optional Outputs

The *LinMot®* *Force Control Unit* includes three outputs which the user may wish to incorporate into their application. These outputs are specific to the *Force Control Unit*, but may be monitored by the PMAC or other external devices. The three outputs are as follows:

1. Warning-Output
2. Error-Output
3. Drive-Enabled Output

The user may bring these signals into the PMAC via JOPTO (PMAC1) , JI/O (PMAC2), or any of the other Accessory 34 I/O devices. These signals may be used in PLC’s to monitor conditions of the application.

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